WORLD HEALTH

THE MAGAZINE OF THE WORLD HEALTH ORGANIZATION · SEPTEMBER-OCTOBER 1991

malaria

Photo WHO/P. Lasco

Breaking the fatal cycle of transmission

by Hiroshi Nakajima

Director-General of the World Health Organization

During the first part of this century, malaria was the most important tropical disease. Large antimalaria campaigns led to eradication in many areas, and to a controlled situation in others. But as this issue of *World Health* shows, malaria still remains a formidable foe. Recent epidemics are telling reminders of how quickly this disease can strike and how great its devastation can be, causing untold suffering and tragedy. They also illustrate how speedily and effectively an international response can be mobilized, once the severity of the situation is recognized and appreciated at the national level.

But epidemics represent only the tip of the malaria iceberg. Even more serious, in terms of the day-to-day toll of illness and death, are the countless situations where malaria is constantly present, whether in vast areas of Africa or in the tropical forests of the Americas. In such areas, malaria makes its presence known through the untold cases of fevers that lead to infant and child deaths, school absenteeism and much loss of working capacity among adults.

Malaria can strike anyone down, but history and experience show that it affects primarily the poorest, most peripheral and most marginal areas or groups of populations. These same people have the least access to health services, can least afford personal protection and are the furthest removed from organized malaria control activities; and it is they who suffer the estimated one to two million deaths per year attributed to malaria.

Wherever malaria is present, it interferes with human progress and development; only by bringing it under control can its disrupting effect be overcome. After appropriate malaria control activities had been introduced,

(Above) The face of malaria. This disease still seriously hampers socioeconomic development in many countries.

they played a major role in the completion of the Panama Canal. Today, we witness increased productivity in the rubber plantations of South-East Asia where malaria is controlled. Communication and socioeconomic development through the building of railways and roads in many tropical countries are also made easier.

Malaria problems arise when development projects and, more importantly, communities and individuals try to bring about economic improvement in disorganized ways which increase contact between man and mosquito, for instance during the irrigation of land and the clearing of forests.

In the fifties, the World Health Organization started a global programme of malaria. Today, more than 20 years after we realized that eradication was not feasible under current economic conditions, our approach has become more pragmatic. There is no "magic bullet" for malaria, and we must therefore fight it on many fronts. As the articles that follow suggest, we have the means to do so.

Every member of the public can use personal protection whenever and wherever the transmission risks are high, and can learn to recognize signs of the disease and seek prompt treatment. Health services can be made available to ensure timely diagnosis and effective treatment. Epidemic warning and control systems can be developed as part of the national epidemiological services.

Without the political will and determination to carry out effective malaria programmes, we will not win the fight against the disease.

Photo WHO/T. Farkas

Where malaria is an important obstacle to development, the capacity to control its transmission can be enhanced by strengthening local and regional epidemiological services.

The battle against malaria continues, but it urgently requires reinforcement. We at WHO are convinced that a determined collaborative effort between the health sector and all the other sectors concerned can succeed in breaking the fatal cycle of transmission of malaria in many parts of the globe even before the present century ends.

Hiroshi Nakajima, M.D., Ph.D.

Photo WHO/R. da Silva

Front cover drawn jointly by Robert Camilleri, Matthew Carlson Morris and Nicholas Harris, International School of Geneva.

IX ISSN 0043-8502

World Health is the official illustrated magazine of the World Health Organization.

Editor:
Eilif Liisberg, M.D.

Deputy Editor:
Christiane Viedma

Art Editor:
Peter Davies

News Page Editor:
Philippe Stroot

World Health appears six times a year in English, French, Portuguese, Russian and Spanish, and four times a year in Arabic and Farsi. The German edition is obtainable from: German Green Cross, Schuhmarkt 4, 3550 Marburg, Germany.

Articles and photographs not copyrighted may be reproduced provided credit is given to the World Health Organization. Signed articles do not necessarily reflect WHO's views. The designations employed and the presentation of material published in *World Health* do not imply the expression of any opinion whatsoever on the part of the Organization concerning the legal status of any country, territory or other area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Contents

Breaking the fatal cycle of transmission
by Hiroshi Nakajima 2

Malaria control: history shows it's possible
by José Antonio Nájera-Morrondo 4

The world malaria situation 6

Strategies for Africa 6

Watch for the symptoms!
by Nicholas J. White 8

Different strategies for different situations
by Peter Trigg 10

Towards better diagnosis
by David Payne 12

Partners against malaria
by John Storey 13

Malaria and the mosquito 16-17

Local wisdom in Mexico
by Francisco J. López-Antuñano 18

Forms of treatment
by Lateef A. Salako 19

The mosquito: public enemy No. 1
by Awash Teklehaimanot & Pushpa R. J. Herath 21

Ideas for action 22

Travellers, beware!
by Penelope Phillips-Howard 24

Risks during pregnancy
by Bernard J. Brabin 26

Economic development and malaria
by Bernhard H. Liese 27

A game of chess
by Michel Lebras 29

News page 31

READEX FICHE

Malaria control: history shows it's possible

by José Antonio Nájera-Morrondo

Malaria has always been one of the most serious obstacles to mankind's efforts to develop agriculture, establish permanent settlements or in any way modify the environment. The earliest civilizations recognized that unhealthy conditions could be created by natural disasters, destructive wars or uncontrolled cultivation of the land.

It is no exaggeration to say that malaria has been responsible for much of the human suffering and misery accompanying the process of social and economic development. It has also largely "fuelled" the vicious cycle of poverty, ignorance and disease. A well-documented example occurred in southern Europe where, in periods of war or economic depression, the use and the care of land declined; this favoured the transmission of malaria, which contributed to further neglect of land and the lowering of its value, so that the least productive areas became even more intensely malarious. This direct association of agricultural neglect with this disease is enshrined in an old Italian saying that "malaria flees before the plough."

Early measures

Protective devices against mosquitos also date far back in history. Herodotus (484–425 BC) observed that in parts of Egypt, above the marshes, people slept in lofty towers which mosquitos could not reach, while people living in the marshlands slept under nets. In the 13th century AD, Marco Polo noted that the wealthier residents of the Coromandel Coast in India slept on bedsteads with curtains which could be closed at night. Later, mosquito nets and window screens were regarded as protection not only from mosquito bites but also from "miasmal exhalations" (bad air), then thought to be the cause of malaria.

Medical treatment for fever also has a long history. Besides magic practices, many herbal remedies were prescribed in different areas of the world, some of them with proven antimalarial action. At least four different remedies, including qinghaosu *(Artemisia annua)*, were used in China during the last 2000 years.

Nobody knows how long the Peruvian Indians knew of the properties of cinchona before 1500 AD, when an Indian chief offered the bark of the "fever tree" to the Jesuit missionary Juan Lopez. Nearly three centuries later a physician and "inspector of epidemics" recommended to King Charles III of Spain that "since cinchona is so effective in treating and preventing this disease, I cannot but

In 1630, the Countess of Chinchon cured her recurrent fever with a decoction from the bark of a Peruvian tree.

Photo WHO

beg Your Majesty to take the most appropriate measures to ensure that all the villages of this continent be provided with such an effective antidote, and that it be sold at a moderate price, so preventing the frequent adulterations that apothecaries (chemists) make of this bark." Cinchona is the origin of today's quinine and its derivatives.

Colonial times

Malaria was a serious obstacle to the colonization of Africa, where the early colonies—particularly in West Africa—paid a heavy price to this disease. Although Europeans were conscious of the risks and even had some knowledge of preventive measures, their urge to exploit natural resources as well as strategic considerations often forced them to establish settlements in highly malarious areas. From the late 18th century, better sanitation at the trading posts and the increasing use of cinchona and later of quinine permitted large-scale European settlement, the massive exploitation of African resources—and a century of intensive slave trading.

By the mid-19th century, quinine was being routinely taken as prophylaxis, a method later standardized by Robert Koch in 1900, after the discovery of the malaria parasite. Nevertheless the disease provoked major disasters. Apart from the failure of the French corporation of Ferdinand de Lesseps during the construction of the Panama Canal, the construction of many roads and railways approached the grim mortality rate of the Mamore-Madeira Railway in north-west Brazil, of which it was said—perhaps with some exaggeration—that it left a dead man for every sleeper laid.

Specific control of the disease began with the discovery of the malaria parasite in 1880 by Laveran, and of the mosquito vector by Ross and others in 1897. These findings led rapidly to practical proposals for the interruption of transmission, and for appropriate diagnosis and treatment of malaria.

DDT insecticide

The idea of malaria eradication, which had been put forward as early as 1916, gained fresh currency after the Second World War—when epidemics had ravaged the devastated areas of southern Europe, while the insecticide DDT had appeared to be extremely effective, not only in controlling those epidemics but also in dealing with malaria in such endemic areas as Guyana (then British Guiana), Taiwan (province of China) and Venezuela.

Tropical Africa and certain parts of South-East Asia posed different problems because of their very high endemicity, their underdeveloped state and their lack of human and financial resources. Successes elsewhere, although slower than had been anticipated, were nevertheless remarkable. But as more and more areas embarked on the consolidation phase of the eradication programme, the expectation that a surveillance mechanism would be sufficient to keep areas malaria-free once the spraying operations stopped was not fulfilled.

More and more frequently, there was a resurgence of the disease, particularly in Central America and South-East Asia, culminating in a massive epidemic in 1958 in Sri Lanka, where malaria had been almost eradicated. Evidence began to accumulate that, although it was possible to reduce and even interrupt transmission by insecticide spraying over large areas, it was very difficult, if not impossible, to maintain efficient surveillance in the absence of a solid health infrastructure. The expectation of global eradication of malaria was finally abandoned in 1969.

Present antimalaria strategies are based on the recognition that, while it is relatively easy—provided there are sufficient resources—to bring about rapid success in controlling malaria by effective interventions, the sustainability of malaria control depends on a complex of ecological, epidemiological, social and cultural factors which vary widely from one area to another.

The main lesson we have learnt from history is that many spectacular successes were ephemeral and followed by severe resurgences, while areas where malaria control was in tune with local health and social development have maintained their malaria-free status.

Appropriate control

Specialized technical competence is essential to the planning of appropriate control measures, as well as to the training and reorienting of health and medical services so as to improve their performance and ensure the health education of the local population.

Great expectations are now being placed on the development of a malaria vaccine. But, again, history shows that some of the major breakthroughs in research were hailed as the final solution to the problem. The discovery of the curative effect of cinchona, the isolation of quinine, the discovery of the malaria parasite and its transmission by anopheline mosquitos, and the recognition of the residual effects of DDT and other synthetic insecticides all led to proposals for the mass control and even eradication of malaria.

Looking back at such proposals, the Second Report of the Malaria Commission of the League of Nations in 1927 commented: "The history of special antimalarial campaigns is chiefly a record of exaggerated expectations followed sooner or later by disappointment and the abandonment of work." Unfortunately that comment is still valid, after the renewed optimism that had been engendered by DDT.

A healthy scepticism towards panaceas for malaria control does not mean it would be justified to abandon the more than one hundred million people now suffering from the disease, or to forget that nearly half of the world's population is at risk. Although malaria eradication is not feasible at present, malaria mortality and a great deal of the suffering caused by the disease can be eliminated by the judicious use of available technology. Eventually, as part and parcel of health, social and economic development, the malaria risk itself can also be eliminated. ■

Dr José Antonio Nájera-Morrondo is Director of the Division of Control of Tropical Diseases, WHO, 1211 Geneva 27, Switzerland.

The world malaria situation

Every year 110 million cases of malaria occur in the world, of which more than 90 million are in Africa, south of the Sahara. WHO estimates that between one and two million persons die from malaria each year, and most of those who die are children aged under five years. Again, the majority of deaths occur in tropical Africa, where transmission is intense and where children are most at risk. Malaria is thus one of the most serious and widespread tropical diseases in the world today.

About 1400 million people live in countries where malaria never existed or where it disappeared without any specific action being taken. Another 1600 million live in areas where malaria was eliminated by antimalaria campaigns, and where it has not reappeared.

Over the last ten years the malaria situation has been worsening in many areas of the world. More than 2000 million people in some 100 countries now live in areas where there is a definite risk of falling sick from malaria (see map). Of these, 500 million, mainly in Africa south of the Sahara, live in areas where the risk is very high and where there are only weak antimalaria programmes or none at all.

In most of the areas of Asia and Latin America where malaria now occurs, it had been considerably reduced or eliminated during the 1960s and 1970s. The situation has been worsening particularly in "frontier areas" of economic development such as agriculture and mining in newly opened jungle, and in areas of warfare, illegal trading and migration of refugees.

In many parts of the world where there are wars and other conflicts, or smuggling and movements of large numbers of refugees across borders, the disease has spread rapidly because no control activities and treatments could be undertaken.

In Afghanistan and Sri Lanka, the disease has reached epidemic proportions. Explosive epidemics, resulting in many deaths, have occurred in Madagascar, Namibia, Sao Tomé and Principe, and northern Sudan.

The *Plasmodium falciparum* malaria parasite has developed resistance to the most widely used antimalaria drug chloroquine, and in some areas to other drugs. Treatment has, therefore, become both less effective and much more expensive. Some of the mosquitos which transmit malaria have developed resistance to the most effective and least toxic insecticides which were used to kill them by spraying the walls of houses. Lack of funds to pay for control activities and treatment has also hampered the fight against the disease. In many areas of the developing world there is simply no health care available for large numbers of people.

The fight against malaria is one of the big challenges of public health today. Experience has shown that it cannot be eradicated or controlled by a campaign approach since the malaria situation in the world is so variable. Effective methods for its control do exist: if selectively applied they can make a major impact on control. What is required is the political will to implement these activities in an efficient way, and sufficient funds to establish or put new life into malaria programmes, including making effective health care accessible, close to where people at risk live. Above all, people everywhere must actively join in the fight. In the final analysis, people's behaviour and attitudes will decide whether malaria will be controlled. ■

E.L.

Strategies for Africa

Malaria is one of the most important health problems of the countries of the African Region of WHO. Of the 110 million clinical cases found today throughout the world, 80% are Africans. An estimated 280 million people are carriers of the malaria parasite, and the situation is worsening all the time. Resistance of the parasites to drugs is steadily gaining new ground, and fresh outbreaks of malaria are being reported from areas which were hitherto hardly affected.

According to the statistics of the United Nations' Population Division in 1990, malaria is the only disease today—apart from AIDS—that shows a significant rising tendency. Last year alone, it was the cause of an estimated 800 000 deaths among children aged under five. In the epidemic areas, it victimizes equally adolescents and young adults.

A serious situation

The total number of deaths from malaria notified by countries to WHO's Regional Office for Africa, while not reflecting the full reality, clearly indicates the present tendency for the situation to worsen.

In the light of this serious situation, a resolution adopted by the 38th session of WHO's Regional Committee for Africa in 1988 invited Member countries to evaluate the malaria situation and the effectiveness of the strategies being used to tackle the problem.

More recently, the Conference of Ministers of Health of the Organization of African Unity (OAU) in April 1991, held at Mbabane in Swaziland, adopted a resolution reaffirming the determination of African states to fight against this disease.

The best hope for progress in the fight against malaria lies in strategies specifically adapted to the different

types of malaria, as described in the article "Different strategies for different situations" in this issue. Malaria control has to be adapted to local situations and resources, particularly as regards the control of mosquito vectors, the use of drugs, information, education and communication activities, and epidemiological surveillance. In all situations, however, the ready access of the affected populations to early diagnosis and treatment of malaria is absolutely necessary.

The participation of local populations and their ability to adopt personal protection measures to prevent transmission will be an essential element. Individual, family and community action could lead to great reduction in the disease.

The fight against malaria requires continuous action at local level. It is therefore vital to integrate it into primary health care activities at the district level, within the framework of the African health development scenario at present being put into effect in the countries of the Region.

Will and capacity

The success of the struggle for malaria control will also depend on the will and capacity of countries to work out short-, medium- and long-term plans appropriate to the resources available locally and to the epidemiological pattern of the disease.

For its part, the Regional Office for Africa will offer technical support to the different member countries for planning, carrying out and evaluating their national control programmes, for training qualified personnel, and for strengthening their capacity for malaria research.

In this context, an Interregional Conference on Malaria is being held from 21 to 25 October 1991 in Brazzaville, Congo, as a prelude to the 1992 Ministerial Conference on Malaria. The Interregional Conference will sum up the epidemiological situation of malaria throughout the continent. It will study control strategies that can be implemented in the context of primary health care and will propose a variety of plans for control adapted to each country, mobilizing to the maximum the human and material resources available during the present decade. ■

Photo WHO/Wendy Stone

800 000 children die every year from malaria in the African region.

Contributed by ***Dr Elhadi H. Benzerroug***, Regional Malaria Adviser and ***Mrs Béatrice Elom***, Press and Information Officer, WHO Regional Office for Africa, P.O. Box No. 6, Brazzaville, Congo.

Watch for the symptoms!

by Nicholas J. White

Malaria is the most important of the parasitic diseases that afflict mankind. Whereas many of the other human parasites seem happy to live in relative harmony with their hosts, the parasites of *Plasmodium falciparum* (one of the four species of malaria) have a tendency to multiply rapidly and in an uncontrolled way in their human hosts, which may prove fatal. The disease is acquired when a biting female anopheline mosquito takes a blood meal. Whilst probing for blood she injects the microscopic parasite which then finds its way to the victim's liver. There it invades a few of the liver cells and develops over a period of one to two weeks. During this period the human host is blissfully unaware of the infection. At the end of this incubation period, the infected liver cells rupture and release a much increased number of parasites into the blood stream, where they rapidly invade the circulating red blood cells. Once inside the red cell, the malaria parasite proceeds to consume the contents of its new home and to grow. At the end of a further two days (or three in the case of *Plasmodium malariae)* the destroyed cell bursts, releasing more parasites which immediately invade more red cells. Thus the infection expands and within a week the victim begins to feel ill.

The symptoms of malaria depend very much on the amount of previous exposure to the disease and thus on the level of background immunity. In

(Above) Mosquitos breed wherever there are stretches of still water.

many parts of the tropics, particularly in Africa, transmission of falciparum malaria is intense, and everyone is infected repeatedly. Children may get severe malaria in the first few years of life but gradually, with repeated infections, most of them develop immunity. By the time they are adults, they no longer show malaria symptoms. In these areas, malaria is a major cause of childhood death. Furthermore, the hard-fought-for immunity of the survivors is easily lost if the subject leaves a malarious area. In other areas of the world, the transmission of the disease is less intense and symptoms develop at any age.

Flu-like symptoms

The first symptoms are a vague feeling of being unwell and weakness, followed by fever. This is often accompanied by headache and muscular aching. Nausea, vomiting and abdominal pain may occur. At this stage the symptoms are indistinguishable from mild flu (influenza), and the patient may not seek medical advice.

The dangerous falciparum malaria may progress in several ways; the most characteristic sign of severe infection is unconsciousness (cerebral malaria). This is a serious disease and one in five patients will die from it. Coma begins suddenly, usually following a generalized convulsion, or more gradually as the patient becomes confused, delirious, and finally cannot be wakened. In children, the deterioration may be rapid. A child who was "off-colour" in the morning may be unconscious by the evening when the mother returns from the fields, and may be dead by the following morning. Cerebral malaria is a medical emergency which calls for urgent referral to hospital or health centre, so that antimalarial drugs and glucose can be given and further convulsions prevented.

Malaria destroys the red cells of the blood, and anaemia develops rapidly. This is a particular problem in childhood and during pregnancy. The patient appears pale and lethargic and may require a blood transfusion (with all the attendant risks of transmitting viral infections such as hepatitis B or AIDS). Other signs which may develop are jaundice, in which the eyeballs look yellow. Rarely, if the patient takes quinine, the urine may become dark coloured or black (blackwater fever). In adults with severe malaria, the kidneys may fail and the patient will need to have dialysis to survive. Renal failure is usually reversible, but the mortality rate is high.

Photo WHO/E. Schwab

(Above) ***Quick action is needed whenever malaria is suspected; some forms of the disease can kill within hours.***
(Below) ***Bouts of malaria prevent children going to school, and interrupt their education.***

Photo WHO/S. Lindsay

Malaria has a reputation for causing teeth-chattering chills and shakes (what used to be called ague), with a splitting headache and high fevers which occur at exactly the same time every one or two days. This "synchronization" of the infection does take place eventually (particularly with *P. vivax, malariae,* or *ovale*—the malarias which very rarely prove fatal). But it takes several days of less regular fever before synchronization takes place, and falciparum malaria may never synchronize. Nowadays treatment is usually given well before this develops. The pattern of fever is therefore not very helpful in making a diagnosis.

All malarias have a tendency to recur. In falciparum malaria, this usually happens within weeks of treatment and represents a "recrudescence" of the original infection, which has not been cleared from the blood—that is, because treatment has failed. With *P. vivax* and *P. ovale*, true relapses occur months, or rarely years, after the primary infection. This is because some of the parasites lie dormant in the liver (these are called hypnozoites or sleeping forms). Relapse or recrudescent infections cause the same symptoms as the primary attacks.

Mosquitos need water in which to breed; so the habits of the local anopheles mosquito vector are what determine the geographic pattern of disease. In many parts of the world, the disease is much more common in the rainy season as mosquito numbers increase.

Malaria is a particular problem in young children and in pregnancy, where it affects both the mother and her unborn baby. Severe malaria is commonly found where people migrate to a malarious area from a non-malarious area—refugees, travellers, itinerant woodcutters, gem miners, soldiers and so forth. Death can usually be prevented by prompt treatment—but the key to this is recognition and the general availability of effective drugs. All too often one hears of returned travellers—especially tourists—who thought they had a bit of flu and could "shake it off" and a day or so later are found unconscious at home; or a child with a slight fever who will not eat or play normally, and then has a generalized convulsion followed by coma. ■

Dr Nicholas J. White is Director of the Wellcome/Mahidol University/Oxford Tropical Medicine Research Programme, 420/6 Rajvithi Road, Bangkok 10400, Thailand.

Different strategies for different situations

by Peter Trigg

Malaria is one of the major public health problems, being found in over 100 countries or areas in the world (see map on page 7). But the risk of dying or being sick from malaria varies from country to country, from area to area of the same country and even within different groups of a population. Epidemics have occurred in countries such as Burundi, Madagascar, Rwanda and the Northern Region of Sudan, where malaria was either very rare or controlled in the past. Elsewhere in the world, while the number of malaria cases is not markedly increasing in most developed and politically and economically stable areas, it is dramatically deteriorating in many frontier areas.

Transmission of the disease and, therefore, the intensity of malaria may vary from season to season and from year to year. Differences in the malaria parasite, the mosquito vector and the human populations as well as in climate and physical environment create a variety of different malaria situations. The choice of drugs, the methods of killing the mosquito and the methods of protecting the population against it will depend on the local malaria situation. So no single strategy for the prevention or control will be applicable to all countries or to all malaria situations.

Diagnosis and treatment

There would appear to be an enormous number of malaria situations but accumulated experience from the past shows that it is possible to describe a limited number, each associated with certain risks and characteristics. Their identification in a country or region should assist health planners, and health workers in the field, to assess how malaria can be best controlled in their countries and areas, and to improve planning and the best use of resources. The provision of early diagnosis and effective treatment of malaria disease should be the essential part of antimalarial action in all situations. Whatever the social and economic circumstances, this is feasible and should be considered a basic right of all populations at risk.

Unfortunately, a combination of insufficient diagnostic and treatment facilities and the increasing incidence of chloroquine-resistant *Plasmodium falciparum*, (which means that all cases can no longer be cured with an inexpensive and safe drug) is in many areas a major problem, so it is essential that treatment failures are recognized early and referred to health stations and hospitals where fully effective drugs should be available. Self-therapy with drugs purchased in the market-place is common, often leading to incomplete treatment and the potential for severe anaemia.

It is important for effective health education to make both patients and their families aware of the risks of malaria and the need to obtain early an appropriate treatment of any fever episode. In addition, health workers and drug providers, including those in the market-place, should be made aware of the need to advise patients on appropriate dosage and treatment schedules of effective drugs.

Major situations

The major malaria situations and their links with control options are given below:

- *African savanna malaria*. Eighty per cent of the world's malaria and 90% of mortality to the disease is estimated to occur in Africa, south of the Sahara, and is associated with this situation. The malaria vectors are principally *Anopheles gambiae* and *Anopheles funestus* which are

highly efficient in transmitting the disease and are abundant, resulting in virtually all of the population becoming infected early in life.

Malaria transmission is relatively stable from year to year, while seasonal variation is related to latitude, altitude and aridity. Population immunity is acquired early in life, and the burden of disease is concentrated in children and pregnant women. Early diagnosis and effective treatment should be the main control measure in this situation, but in some areas, especially where the transmission season is short and a certain level of development has been reached, impregnated bednets may be useful. There is a gradual transition from the typically stable savanna malaria to desert and highland fringe malaria.

- *Desert fringe and highland fringe malaria* occurs in ecological transition zones where populations with low immunity are subject to serious disease as a result of population movements, climatic changes, or changed patterns of agriculture. There is a considerable risk of epidemics. In highlands, the epidemics may be related to increased mean temperatures, while in arid zones, increased rainfall is the main cause. The former situation was recently seen in Madagascar when, following the interruption of transmission for 20 years by the use of DDT, mosquito vectors increased on the high plateau and were responsible for tens of thousands of deaths from malaria. Close surveillance, designed according to the local situation, and preparedness for intervention with drugs for treatment and – if possible – insecticides for vector control are needed.
- *Malaria associated with traditional agriculture in plains and river valleys outside Africa* can, like savanna malaria, be considered a "background" malaria situation, but transmission is less intense. Development of health services and house spraying have led to low levels of endemicity in many of these areas. Many existing control programmes require reorientation towards improved diagnosis and treatment, sustainable vector control methods, and ability to respond to situations of increased risk.
- *Forest related malaria* is in Africa akin to savanna malaria, with similar control options, although transmission may be less intense. In Asia and the Americas, forest related malaria presents a variety of situations where transmission is usually not amenable to classical vector control methods and lack of social organization is an obstacle to the establishment of good health services. Personal protection measures and early, effective treatment are usually the most realistic control measures.
- *Malaria associated with extensive agricultural development* is related to the influx of workers with little immunity, irrigation or other environmental modification, and insecticide resistance. Environmental measures built into the irrigation systems are desirable, but not always possible. House-spraying, drug prophylaxis and personal protection may then be considered, although the two former methods pose problems of sustainability. The crops which are most commonly associated with increased malaria risk are rice, sugar cane and bananas, because of irrigation, and cotton, because of seasonal labour and massive use of insecticides.
- *Urban malaria and malaria in planned human settlements.* Except for southern Asia, where *Anopheles stephensi* is adapted to breeding in various containers, malaria does not occur in well-urbanized, densely populated areas. In peri-urban slums, malaria transmission by rural vectors may be very intense, often varying greatly over short distances. Planned

Photo WHO/J.A. Nájera-Morrondo

Rapid development often creates favourable conditions for the disease to gain ground.

Workers in rice paddies are particularly at risk.

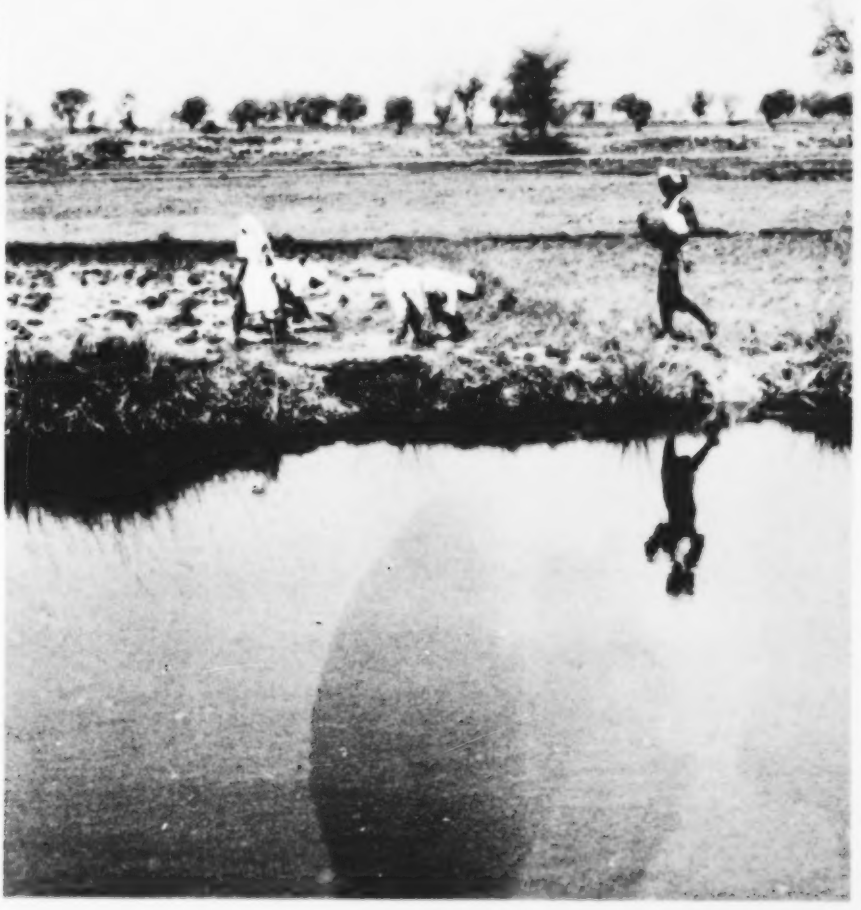


Photo WHO/J.A. Nájera-Morrondo

Different strategies for different situations

human settlements in rural areas, for example, settlements related to development projects, present similar characteristics. The physical planning for all such areas should include selection of a suitable site and the provision of environmental sanitation to eliminate existing breeding sites and prevent the creation of new, artificial, ones. In addition, man-mosquito contact can be reduced by improved house construction and protection.

- *Coastal and marshland malaria* is related to the presence of mosquitos which breed specifically in brackish water. In South-East Asia and the Pacific Islands, these can be responsible for very serious problems. In some places, the development of tourism entails control requirements and options similar to those of urban planning. Some areas are amenable to engineering measures such as drainage, filling and flushing of estuaries or canals with sea water.
- *Malaria in war zones and areas with sociopolitical disturbances.* These events result in the displacement of populations, breakdown of health care and disruption of agriculture that may increase mosquito breeding. Serious outbreaks may result. Depending on the situation and the resources available, it may be possible to consider mass fever treatment, temporary prophylaxis, spraying of shelters as well as personal protection.

Smallpox was eradicated because of a "magic bullet" – a very effective vaccine was available. The fight against malaria is more complicated because the potential for transmission and the effectiveness of control measures varies with the different characteristics of the plasmodium, climate and physical environment, and the habits of the people vary from place to place.

But we do have the technical means to dramatically reduce the impact of malaria. What is needed is political will, a minimum of well-managed resources, dedicated malaria specialists and general health workers, and – maybe above all – active participation by people everywhere. ■

Dr Peter I. Trigg is a Scientist with the Malaria Control Unit, WHO, 1211 Geneva 27, Switzerland

Towards better diagnosis

by David Payne

In 1880 a French army doctor, A. Laveran, working in Algeria, took some blood from a sick soldier. Examining it under his primitive microscope, he saw, and subsequently described, what we know today to be the parasites of *Plasmodium falciparum*.

One hundred and ten years later we still use the combination of the human eye and the ordinary microscope to make the definitive diagnosis of malaria. Of course, since Laveran's time, there have been great improvements in the optical quality of the microscopes, and special stains have been developed which colour the parasites so that they can be more easily recognized. Today an experienced microscopist working at a magnification of 600 to 700 times can readily detect and identify all four species of human malaria parasite and, by determining which blood forms of the parasite are present and in what numbers, can greatly assist the doctor in choosing the appropriate treatment for that patient. In addition, by following up the patient with further blood examinations, the microscopist can aid the doctor in monitoring the patient's progress by quickly detecting any signs of treatment failure.

Unfortunately, such a level of microscopy requires resources of materials and skills which are not always available—particularly at the village level of the health services of the most malarious countries, where the majority of the malaria infections are treated.

Malaria research workers have always been in the vanguard of the efforts to find new and better diagnostic methods to facilitate the rapid diagnosis of malaria at the remotest points of the health care system.

An early approach was to detect the antibodies that a person suffering from malaria produces against the parasite. But this procedure is time-consuming, and high levels of antibody may only be present after the infection has been active for some time: too late for the rapid and early diagnosis which is essential for effective treatment, particularly when the patient is seriously ill. Nevertheless, these techniques have proved to be of great value to medical specialists studying the long-term effects of the disease in the community.

Another approach has been to identify particular groups of molecules which occur on, and are specific to, a particular species of the malaria parasite. These antigens, so called because they stimulate and react with the antibodies of the malaria patient, can be readily detected and identified. But the techniques needed are rather complex and time-consuming, and are not yet of the same reliability as good microscopic diagnosis.

The article by Professor Lebras on page 29 explains how new techniques will in the future greatly facilitate diagnosis. Current experiments aimed at enhancing the power of detection of these techniques will replicate the selected parts of the genes millions, or even billions, of times to allow their detection by simple visual methods which are rapid, cheap and reliable.

Photo WHO/P. Pittet

It is hoped that these new techniques will lead to the mass production of simple diagnostic tools based on a dipstick or card. A small quantity of blood obtained from a finger prick will be brought into contact with the surface of the dipstick or card, where, if malaria parasites are present, incorporated reagents will react with specific molecules in the malaria parasites to produce a visible reaction. In this way it should be possible to identify what parasite forms are there, and give a good estimate of the density of the infection. A similar test system could also tell the doctor which antimalarial drug, if any, the malaria patient had already taken and how much, and to what degree the parasite is resistant to the common antimalarial drugs.

Armed with this information, the treatment of malaria patients at all levels of the health service would be enhanced, and the battle for the control of the disease would be made that much easier and more effective. ■

Dr David Payne is a Scientist with the Malaria Control Unit and the Special Programme for Research and Training in Tropical Diseases, WHO, 1211 Geneva 27, Switzerland.

Partners against malaria

by John Storey

Malaria has been responsible for sickness and death in rural communities for centuries. In the late 1950s Malaysia embarked on a malaria control project which was later converted to an eradication programme. Initially it met with considerable success. Large areas of Peninsular Malaysia and of Sabah and Sarawak on Borneo are today still free of malaria. But problem areas remained. It was clear that eradication could not be easily achieved and the programme reverted to one of control. Today, malaria control remains the main activity of the Vector-Borne Disease Control Programme of the Ministry of Health.

Village bednets

In effect, the Ministry of Health has established a partnership with communities in various parts of the country to tackle this age-old disease. I was invited to see how this partnership works, starting at Kampong Jerek in Kelantan State, in the very middle of Peninsular Malaysia. The neighbouring area had 46% of the State's total malaria cases in 1990.

"Difficulty of access is one of the major problems in the areas where malaria still occurs", said Encik Waniz-zedin Wan Sulaiman, the State medical entomologist, as we made our bumpy way to the kampong (village). "*Anopheles maculatus* is our local malaria vector, and it thrives in the slow-moving water seepages in the hilly country around the villages in this area. Residual spraying has not worked well because the insect prefers to feed and rest outside the houses.

"In 1985 we decided using local volunteers as primary health care workers (PHCWs). They were trained to make finger-prick blood films from fever cases so that we could quickly identify and treat the malaria cases. We encouraged the community to form a village health committee, and explained the advantages of every family unit being involved in their immediate health care. As Malay communities are very self-contained, this proposal was quickly taken up and has worked well ever since.

"Shortly after, we proposed that they consider sleeping under permethrin insecticide-treated bednets to further reduce the level of malaria cases. The villages agreed, and women's groups sewed many of the nets which were issued to each family. A nominal sum was paid for the net but permethrin treatment was free. As the nets need to be retreated every seven to eight months we trained the PHCWs to do this as well."

Later I met Encik Ishak bin Pakadik, one of the primary health care volunteers. He doubles up as a PHCW in both the Jerek school (where he works as a gardener) and in the village. Since he started in 1985 he has been responsible for identifying more than 190 malaria cases in schoolchildren. "I volunteered because I wanted to help

Women in Jerek, Malaysia, sew the bednets themselves — a prime example of community participation in action.

Photo WHO/WPRO/J. Storey

Photo WHO/WPRO/J. Storey

As a primary health care volunteer, Encik Ishak is deeply committed to the fight against malaria.

prevent malaria. I knew it was responsible for keeping many children away from school, and this was the best way I could help." Ishak helps to coordinate activities when bednets are due for retreatment, as well as giving simple first aid and health care, for instance providing oral rehydration salts to diarrhoea cases.

Flushing out the larvae

Gombak lies in Selangor State, about 10 kilometres from Kuala Lumpur, the capital of Malaysia. Here in the Gombak valley is the Orang Asli hospital, which specializes in treating the Orang Asli ethnic minority, a group of shy, retiring people who have lived for a long time in the deep forests and jungles of Peninsular Malaysia. The government built this hospital in the 1950s. Seriously ill cases are flown by helicopter from widely scattered clearings in the jungle nearly every day.

As with most Asian households, members of the family accompany the sick person to help provide care, and live in locally provided houses dispersed over the surrounding hillsides. "Of course many of these family members arrive with malaria, so they are a source of infection to others, especially to the younger, less immune children", said Encik Hashim bin Abdul Aziz, State Health Inspector of Selangor State.

"We found ourselves with cases of malaria being transmitted regularly in the community, so we had to find a way of reducing the number of cases. We were dealing with *Anopheles maculatus* which breeds in the rocky, sunlit pools in the forest.

"In the past we had tried to control this vector by using malariol, an oily product which floated on the water's surface and interfered with the mosquito larva's breathing syphon. Unfortunately, the oil didn't reach into the rocky fissures which *maculatus* favours in this area and, besides, malariol is now environmentally unacceptable.

"So we went back to earlier methods of using water management as a form of larval control. We improved the old system of automatically flushing out the *maculatus* breeding places by using simple, cost-effective methods. We used local materials and the community was involved throughout the programme. Before we did anything, though, we constructed scale models to see whether our modernization of the system really worked."

Encik Hashim showed me three fully-working scale models of the systems I was to see later on the hillsides above Gombak's scattered houses. The models showed how the central cistern would be sited high up the hill at the source of a stream, filling up with water and then releasing a torrent to wash away any mosquito larvae in its path.

Encik Hashim told me: "To build such a system takes not only money, which we did not have, but dedicated support from the health staff and the community. We were lucky though: we got both. Funds were provided by a local donor, and a local cement factory donated 150 bags of cement. The Orang Asli and the local community provided all the voluntary labour and, as you can see, we made an environmentally acceptable system which will last for many, many years, requiring little additional care or maintenance.

"The system is so simple that the local people are able to look after it themselves. In the three years 1986 to 1988, we had 100 locally transmitted cases of malaria, quite a serious problem so close to Kuala Lumpur. In the two years since the flushing systems were built, that is 1989 and 1990, we have had no cases at all and that has continued until today."

Sabah's problem area

Sabah, over 1200 kilometres from Kuala Lumpur and two-and-a-half hours by plane, has for many years been the malaria problem area of Malaysia, with between 25 000 and 45 000 cases per year. The vector is *Anopheles balabacencis*, one of the most efficient vectors in south-east Asia. And until recently Kudat District was the problem area of Sabah.

"The situation was so bad a few years ago that we just did not know what else could be done," Dato (Dr) Michel Chen, State Director of Medical Services, told me. "Finally we decided to try using PHCWs to identify and treat malaria cases as early as possible, so as to reduce the number of severe and complicated malaria cases due to *Plasmodium falciparum*, the species which causes cerebral malaria. I think that

you will see that we have been very successful."

From the state capital, Kota Kinabalu, I travelled by jeep three hours north to Kudat District, a peninsula jutting into the sea towards the nearby Philippines. Although the area was bone dry, the entomological workers were still catching *Anopheles balabacencis* mosquitos, mostly outside houses between sunset and midnight.

At Kampong Timug, in hilly country with thick jungle, we met two volunteer PHCWs who hold the award for collecting the highest number of blood films from fever cases in 1990. One man and his wife have taken more than 2000 films since 1988 and have identified more than 180 cases of malaria.

"From our observations in this area", said Encik Edward Pudin, senior malaria technician for Kudat, "we do not consider drug resistance to be a serious problem in these communities. And with our PHCWs in the kampongs we are able to keep a better track of what is going on."

Chee Kim Chuan, a malaria technician, started the volunteer system in September 1988 by encouraging the village communities to form health committees and asking for volunteers. He arranged one-day training courses designed to help the PHCW to recognize the signs and symptoms of malaria, make a thick and thin blood film, and give the patient the first treatment and advice on how to avoid malaria in future. He maintained contact with these volunteers and continued to provide support and further training.

Every day, private vehicles passing the PHCW's post collect blood films and deliver them to the laboratory in Kudat town. There they are quickly examined and the results are relayed by returning private vehicles to Kampong Timug.

Today, trials using permethrin-treated bednets are underway in 11 kampongs. Preliminary results are very encouraging but it is still early and no one pretends that malaria can be beaten easily. Dr Moh'd Shukur, the Medical Officer of Health in Kudat, told me: "It is essential to have support from the highest levels of the Ministry as well as the continuing support from the community. Training sessions, meetings and incentives to the PHCWs all cost money and effort.

"On completion of their training each PHCW is awarded a certificate. They also get a painted sign to hang outside their house as well as a treatment box and a T-shirt identifying them as a PHCW. This way we have been able to maintain their interest. I cannot be sure, but I feel that the reduction for Kudat from 6700 malaria cases in 1985 to 3600 cases in 1990 is mostly due to this." ■

Mr John Storey is a Scientist with WHO's Regional Anti-Malaria Team, c/o WHO Representative, P.O. Box 12550, Kuala Lumpur 50782, Malaysia.

A model was constructed of a system that would destroy the mosquito larvae by flushing them out of the water supply.

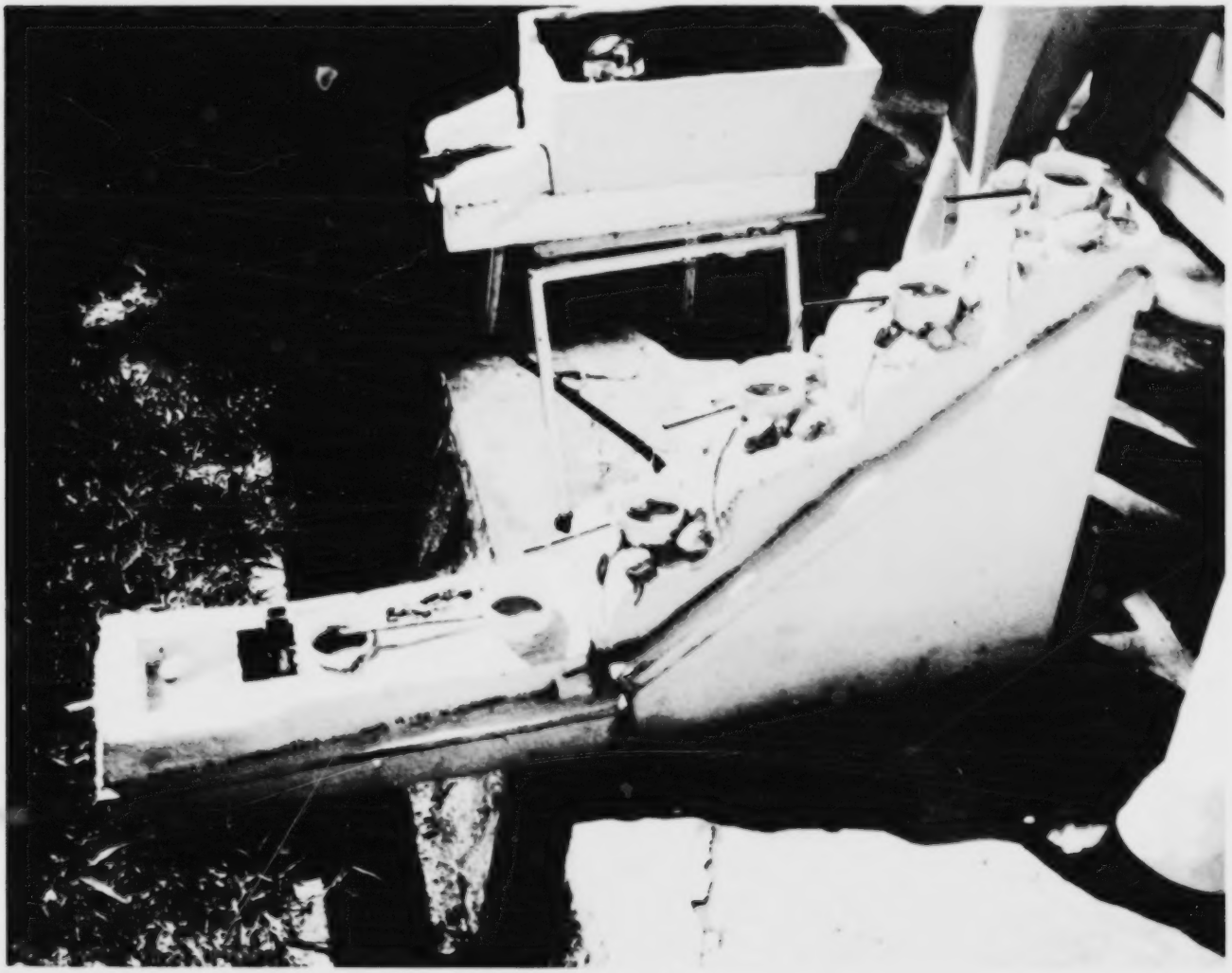
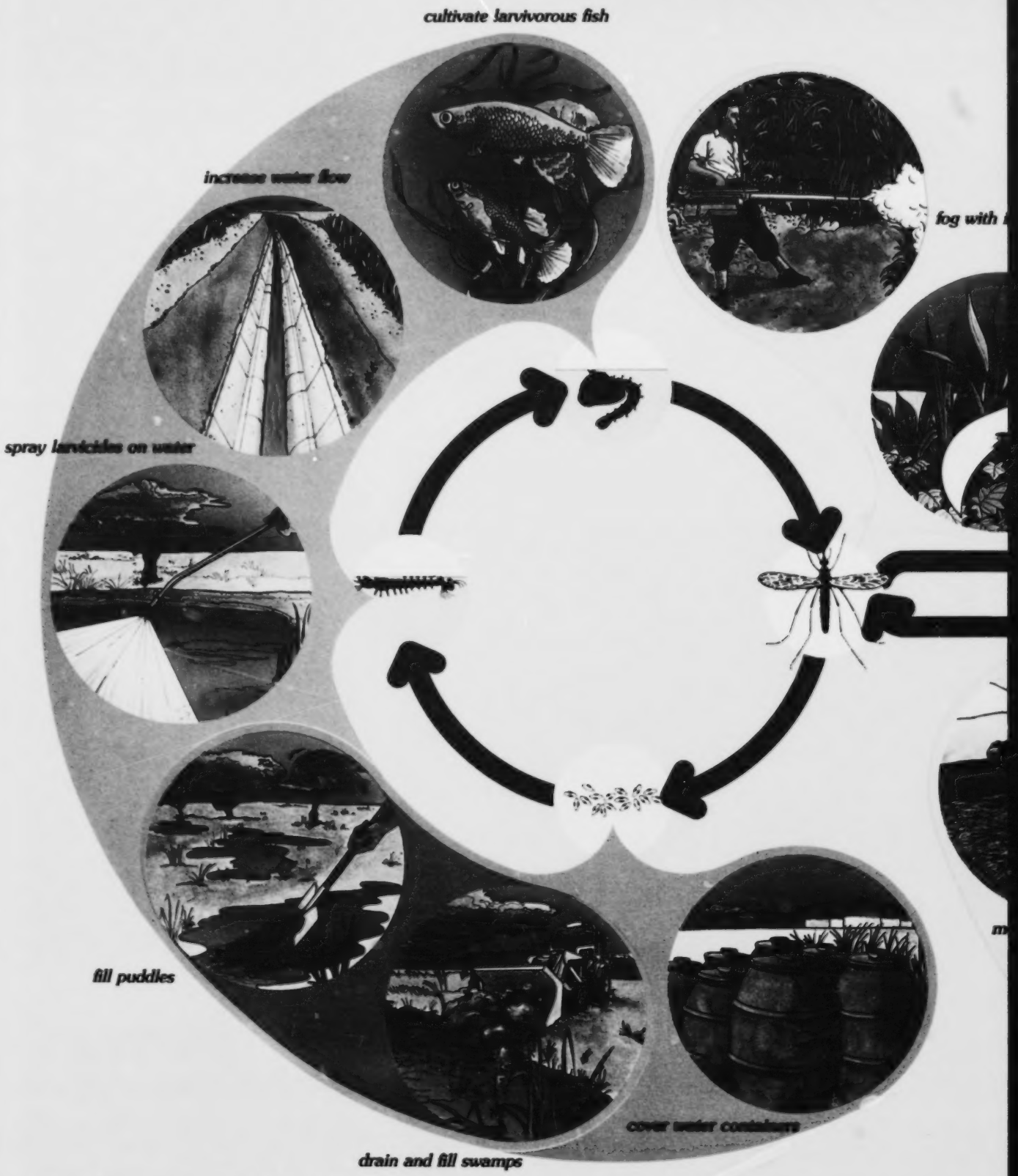


Photo WHO/WPRO/J. Storey

Malaria and



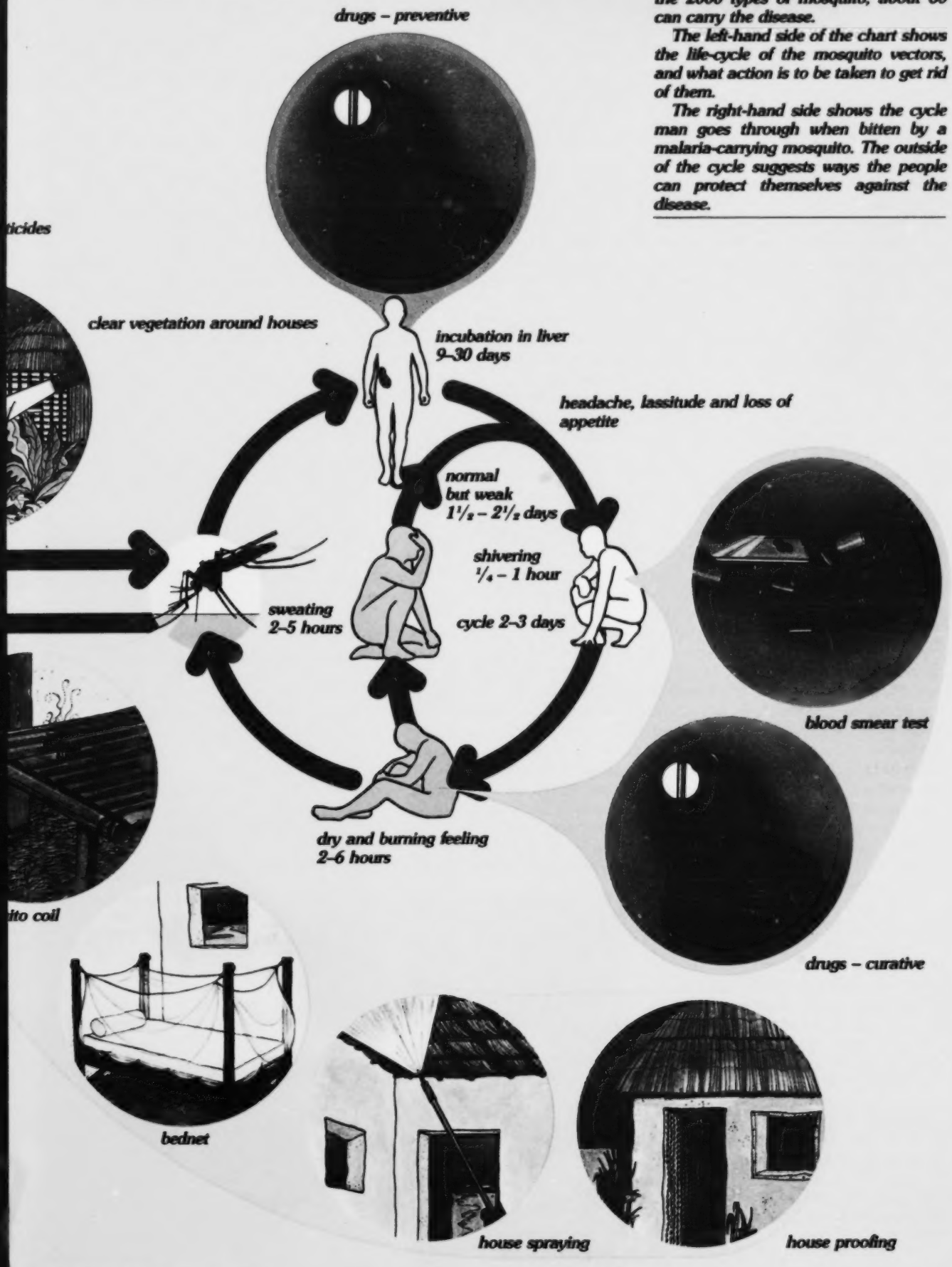
This poster has been reproduced by kind permission of the originator (Shell International Petroleum Company Limited)

he mosquito

"Malaria and the Mosquito" has been drawn to show how malaria spreads and what can be done to prevent it. Of the 2000 types of mosquito, about 60 can carry the disease.

The left-hand side of the chart shows the life-cycle of the mosquito vectors, and what action is to be taken to get rid of them.

The right-hand side shows the cycle man goes through when bitten by a malaria-carrying mosquito. The outside of the cycle suggests ways the people can protect themselves against the disease.



Local wisdom in Mexico

by Francisco J. López-Antuñano

Malaria is predominantly a disease of rural areas and the patient falls sick at home, often distant from the nearest health services. But there is much that can be done at the community level to prevent the suffering from disease and its spread, when the population is aware of the risks, is well organized and has the necessary resources. This is illustrated from an experience some years ago when our malaria research team visited a small town called Guadalupe, near the capital city of Oaxaca, in the State of Oaxaca, Mexico. We were particularly interested in studying the local situation of malaria—one of the most complex and frightening public health problems in developing countries.

At that time, only 185 people were living in the village, over 60% being children under 14 years of age. The adult working population was extremely small because of migration. The women went to Oaxaca city to work in the shops, restaurants or hotels, while the men went to northwest Mexico or southwest USA, mainly to work as agricultural labourers. Those who were left in the village maintained on a small scale either cattle or pigs or had *parcelas* (small plantations) of corn, beans, tomatoes and other vegetables, and fruits. Almost every household had some chickens and turkeys for eggs and meat.

The official authority in the town was Mr Apolinar Cruz, the *encargado del orden*, a sort of delegate from the "Municipio", who was a combination of social worker, policeman, public work adviser, and natural community leader. He was very effectively assisted by the *topil* or weekly assistant. The weekly assistant title is explained by an ancient custom in the Zapotec culture that each male member of the community between 18 and 60 years of age serves his community for a whole week in turn, for the benefit of the social group and to ensure environmental protection within the locality.

When we arrived in Guadalupe, Mr Cruz explained that there had not been any serious malaria cases in the village or even in the whole valley for decades. However, a 12-year old girl, Cecilia, who lived on the outskirts of the village, had been sick two days earlier with typical malaria fever. The villagers were aware of the fever-reducing effect of "ajento tea", an infusion of a local herb, and Cecilia's mother had treated her with it. Her teacher had been provided with antimalarial drugs and he had also treated her immediately with a full treatment dose of chloroquine. He had sent a smear of blood to the malaria service in Oaxaca City, which promptly confirmed the diagnosis of malaria. Three days later, with our support and assistance, a team from the malaria service started to identify mosquito breeding sites and looking for other possible malaria cases. That is how we discovered that Juanito, a two-year-old boy, was also infected. Juanito's parents were confused and concerned about his fever because he had already been inoculated with all the children's vaccines against diphtheria, whooping cough, tetanus, tuberculosis and polio, and he showed no symptoms of either diarrhoea or respiratory disease. It was probable that malaria had returned to Guadalupe when Cecilia's older brother visited the village. He must have been infected in another part of Mexico.

The mosquito breeding sites were identified and the villagers, with the assistance of the malaria services, Mr Cruz and the *topil*, controlled the water supply of the village and eliminated stagnant pools which were potential breeding sites of the malaria-carrying mosquitos. To be doubly sure, they also put more *charales* (*Poecilia* and other small fish) into all the water sources because they knew that they eat the mosquito larvae and would in addition increase the village's supply of food delicacies.

Community awareness

Both Cecilia and Juanito were cured and the village was provided with better facilities. But migrant workers continue to return and the villagers have to maintain their surveillance to prevent more of their children falling sick from malaria. The case of Guadelupe is unfortunately unusual. Where malaria exists today it is rare that the local environment permits sustainable control by a few simple measures. However, the importance of community awareness and initiative is universal and well illustrated by this example. ■

Dr Francisco J. López-Antuñano is Area Director, Health Programs Development, WHO Regional Office for the Americas/Pan American Health Organization, 525, 23rd Street N.W., Washington, D.C. 20037, USA.

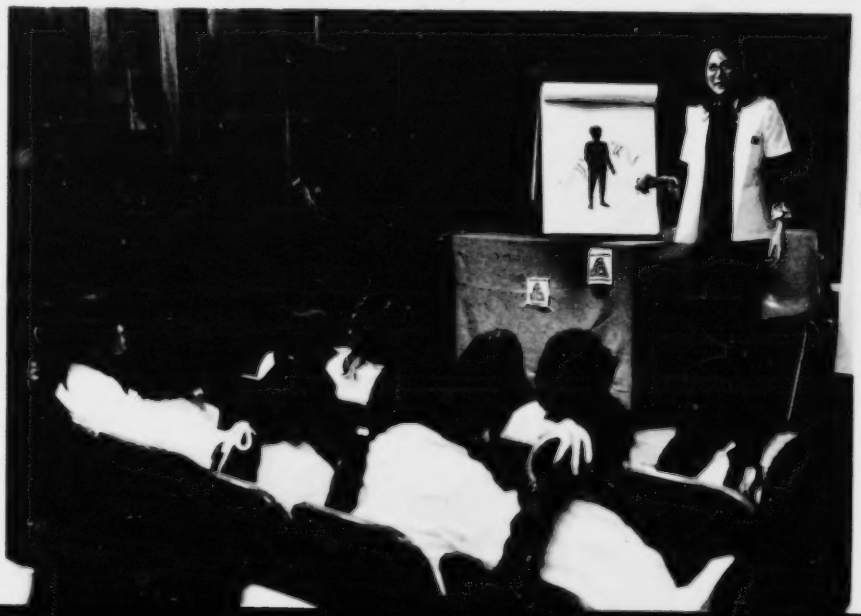


Photo WHO/P. Almasy

Teachers are key participants in the fight against malaria at the community level.

Photo WHO/P.Pittet

Forms of treatment

by Lateef A. Salako

Four different forms of malaria occur in man, the two commonest being vivax malaria and falciparum malaria. The latter causes the most severe illness. Death occurs quickly in these severely ill patients, and can be averted only if effective treatment is started promptly.

There are two aspects to the treatment of malaria. Specific antimalarial drugs destroy the malaria parasites in the body. Supportive treatment relieves symptoms and signs such as fever, anaemia and convulsions.

From cinchona to chloroquine

The modern drug treatment of malaria can be said to date back to about the year 1630, when a Jesuit priest in Peru recognized the potential value of the bark of the cinchona tree for treating a fever which was then a common cause of illness in Europe. An extract of the bark was reputed to have been used by him to cure the wife of the Spanish Viceroy of Peru, the Countess of Chinchon, of an acute attack of fever. The name of the tree derives from this story.

The cinchona tree was eventually found to be specific for the type of febrile illness now recognized as malaria. It was not until 1820 that quinine was identified and isolated as the active antimalarial compound in the plant. The active principle has since been synthesized, but quinine is still being extracted from the bark of the cinchona tree which grows in large plantations in Africa and Asia.

During the two World Wars, a number of synthetic antimalarial drugs were developed. At the end of the Second World War chloroquine was introduced. It dominated the malaria drug treatment scene for the next three to four decades because of its effectiveness, low cost and safety.

Chloroquine is still the most widely used antimalaria drug.

Resistance of the parasites to chloroquine first appeared in the late 1950s and early 1960s in South America and Asia, and has since spread to practically all endemic countries. It has similarly been developing to other available antimalarials. Resistance has become one of the greatest stumbling blocks to the effective drug treatment of malaria. It is therefore important for every country with malaria to have a drug susceptibility surveillance programme to monitor drug resistance and adapt treatment accordingly.

Malaria is predominantly a disease of the rural areas. With the increasing adoption of primary health care in endemic countries, health centres are being set up in rural areas with staff who know how to manage local health problems. But these facilities can only treat the mild and uncomplicated form of malaria because of the limited knowledge and skills of the primary health care workers, who lack diagnostic facilities. They should be able to recognize severe cases and refer them to appropriate higher health care levels. In some localities, out of ignorance, habit and inability to afford the cost, people rarely seek modern health care early in the course of their illness. Many therefore go to the hospital and health centres only after complications have set in.

Ideally we should aim to be able to treat all cases of malaria, except cerebral malaria and those patients requiring highly specialized supportive therapy and nursing care, at even the most remote health facilities. Only then will we be able to reduce morbidity and mortality from malaria through chemotherapy.

Choice of drugs

At present we have only a small variety of drugs to choose from in malaria treatment. The choice of drug is determined by the sensitivity to drugs of the malaria parasites in the area, by the level of health care at which treatment is to be given, by the severity of the infection, and by the drug's availability and cost.

In spite of the problem of resistance, chloroquine is still the most widely used antimalarial drug. In some countries of South-East Asia, resistance to it is so extensive and is of such a high degree that it is now no longer a drug of choice. In most other parts of the

world, particularly Africa, it is still the drug of choice for uncomplicated malaria. It can be taken by mouth as tablets or syrup. The dosage schedule is simple, consisting of three or four doses over a three-day period. Its effect is rapid, and the fever and parasitaemia disappear usually within three days in sensitive cases. It is well tolerated, although a peculiar type of itching, not accompanied by rashes, occurs in 10% to 25% of Africans. The itching is self-limiting, lasting 24 to 48 hours, and although it can be severe while it lasts, it has not significantly affected the usefulness of the drug.

When a patient fails to respond to chloroquine and the diagnosis has been confirmed by blood test, an alternative drug should be used. One of these is sulfadoxine-pyrimethamine or similar combinations of pyrimethamine with a long-acting sulfonamide. These drugs are available as tablets and are given as a single oral dose. Their effectiveness has remained high in most of Africa, but resistance to them is widespread in most of Asia, where they are no longer a useful choice for falciparum malaria. In sensitive cases, sulfadoxine-pyrimethamine clears the blood of malaria parasites as rapidly as does chloroquine, but fever and other symptoms are slower to disappear. The drug is well tolerated in the single-dose therapy for acute malaria, but repeated administration may lead to skin reactions which can be severe or fatal. It is not advisable to give the drug to newborn babies, in whom it could cause severe jaundice.

In countries of South-East Asia where chloroquine and sulfadoxine-pyrimethamine resistance is widespread, quinine is increasingly being used as the first or second line drug for malaria. This is also true of some French-speaking African countries, even when there is no such resistance problem. In these countries, formulations containing a combination of cinchona alkaloids (quinine, quinidine and cinchonine) rather than quinine alone are popular. The combination is thought to reduce the risk of adverse reactions.

However, quinine is not so well tolerated as chloroquine, since in normal treatment doses it produces a complex of symptoms and signs referred to as cinchonism, comprising dizziness, tinnitus, blurring of vision and tremors. These are usually mild, often do not require stopping of treatment and subside when the treatment is ended. Overdosage can cause deafness or blindness. The duration of quinine treatment, along with the side-effects, may stop the patient taking the drugs. The treatment period can be shortened by combination with tetracycline. This drug should not be given during pregnancy or to growing children because it may cause brownish discoloration of the teeth and slows down the growth of long bones.

One of the newer antimalarial drugs which is being increasingly used to treat uncomplicated malaria is mefloquine. In most countries, it is used as a second or third line drug when the drug of choice has proved ineffective, but in a few countries with multi-drug resistance problems it is increasingly being used as a first line drug. It is given orally and acts rapidly. Resistance to mefloquine has also appeared and is on the increase in some countries.

A new antimalarial drug, halofantrine, has now been registered for use in a number of countries. It is given orally, and its efficacy and safety are still under study.

A plant against malaria

A proven herbal remedy: qinghaosu

Artemisia annua

Artemisia annua, or sweet wormwood, has been used to treat fevers for almost 2000 years in China. Artemisinin, a promising new antimalarial drug, is extracted from the leaves and flowering tops of the plant. Since 1972, China has supported a number of studies on use of the drug to treat malaria. Chinese practical experience with the drug indicates that it is both effective and well tolerated by the patient.

Treating severe malaria

In severe malaria rapid and effective treatment is lifesaving. Patients should be admitted to hospital and treated by intramuscular or intravenous injection. The drugs currently in use for this purpose are quinine, chloroquine, sulfadoxine-pyrimethamine and artemether.

Quinine is presently the drug of choice for cerebral and other forms of severe complicated malaria. It is given by very slow intravenous infusions which are repeated until the patient can take medication by mouth. Then treatment is continued for up to seven days with quinine tablets.

Chloroquine injections are widely used and are effective when the parasite is not resistant to them.

An effective but little used method of treating severe malaria is a single dose of intramuscular sulfadoxine-pyrimethamine. In Nigeria, we have studied and used this treatment in children who have severe malaria but are not in coma, and have found it to be more effective than chloroquine.

The newest addition to the treatment of severe malaria is injectable derivatives of the traditional Chinese herbal remedy known as qinghaosu or artemisinin. These drugs clear the blood of malaria parasites faster than any other class of antimalarial drugs and are now in the final stages of testing for international registration. It is hoped that they will prove useful for reducing the rate of deaths from cerebral malaria.

We would expect communities with malaria to have evolved traditional treatments for the disease. Indeed they have! Prominent among this is the use of local herbal remedies. Those who use these traditional remedies have absolute faith in their efficacy, but most modern health care providers are not so convinced. Scientists in endemic countries have investigated the antimalarial properties claimed for various herbs, but with little positive results to show for their efforts so far. This initial lack of success has not dampened the enthusiasm with which the studies are being pursued—particularly in view of the experience with quinine and qinghaosu, which were both developed from traditional herbal remedies. ■

Professor Lateef A. Salako is Professor of Clinical Pharmacology, Department of Pharmacology & Therapeutics, College of Medicine, University of Ibadan, Ibadan, Nigeria.

The mosquito: public enemy No. 1

by Awash Teklehaimanot & Pushpa R.J. Herath

Human malaria is normally transmitted from one person to another by the bite of a female anopheles mosquito infected with malaria parasites. It is only the female anopheles mosquito that bites and feeds on people. The male mosquitos feed only on plant juices and thus do not play any role in the transmission of the disease. The females need blood as a source of protein for the development and maturation of their eggs. Their mouth parts have developed so that they can pierce through the skin and blood vessels and suck blood. They also excrete anticoagulants to prevent the blood from clotting as they feed.

There are some 400 species of anopheles mosquitos, but only about 70 species are known to be responsible for transmitting malaria. About 30 are of major importance, responsible for a significant amount of all malaria cases. In Africa, the most important vectors are members of the *Anopheles gambiae* group and *A. funestus*.

It is not clearly known why some species of mosquito are susceptible to malaria infection and others are not, or why some are more effective in transmitting the disease than others. These differences are partly explained by the way they feed, how long they live and how many there are. Some vectors feed exclusively on humans every 2 to 3 days, while others feed either on humans or other animals as opportunities arise.

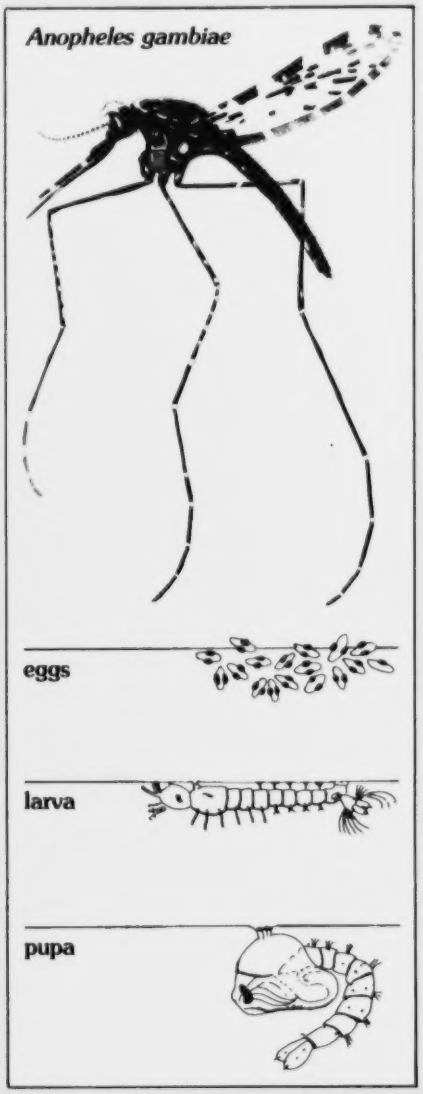
Mosquitos have four distinct stages in their life history—the egg, the larva, the pupa and the adult. The first three stages occur in water while the adult is an active flying insect. Anopheles eggs are laid singly on the water surface and hatch into the larval stage within one to three days.

The larva is an active feeder and obtains its food from the water in which it lives. After about ten days, the larva moults into a pupa, which also lives in water. It does not feed, but has to come to the surface from time to time for air. After one to four days the pupal skin splits and the adult mosquito slowly works its way out. It rests briefly on the water surface and then flies away. The adult has an average flight range of one to two kilometres. Its life span can vary from a few hours to a few months.

Anopheles mosquitos have successfully adapted so that they can breed in almost any stagnant sheet of water from lakes down to temporary pools, cattle hoof prints and discarded containers. They can thrive in fresh or brackish waters.

Malaria transmission can be prevented or reduced through different control methods directed against the aquatic stages and the adult mosquitos. The most direct and obvious precaution is to avoid being bitten by mosquitos using methods explained on pages 22 and 23.

Locating houses, villages and settlements away from major breeding sites will reduce the threat of mosquito bites. But this will call for a good water supply that is not dependent on water where the mosquitos breed. Improved housing design and construction to prevent mosquitos from entering and resting indoors would also reduce the danger of bites.



Many mosquito breeding sites such as domestic water storage containers, abandoned mines, pits resulting from housing and road building, wells, drains and irrigation systems are created by people themselves. People can take action to counter some of these.

Chemical compounds such as temephos can kill the larvae in the water but they are only suitable when breeding sites are few and the areas involved are limited. Of course, toxic substances must not be applied to water used for drinking or washing.

Standing pools of water near houses should be filled or drained off and irrigation canals should be properly maintained and cleared of vegetation to allow the free flow of water. Periodical drying and flooding of rice fields for short periods to disrupt the mosquito life stages have proved effective in some countries.

Some types of fish eat mosquito larvae. Certain so-called "annual fish" (genus *Notobranchus*) can survive droughts and may be used in bodies of water that are not permanent. The use of larvivorous fish is ideal for community involvement. It is best if these fish can be bred along with types that can be eaten, as the breeding of such fish gives an additional financial motivation! Fish that feed on plants can also help to keep the edges of canals and drains free of vegetation, facilitating the free flow of water.

Different types of insecticides are available to kill adult mosquitos. The "knock-down" insecticides are effective for a matter of days while the "residual" insecticides may last for months.

DDT has been the most widely used residual insecticide since its introduction in the 1940s. It is also the cheapest and safest for indoor use against adult mosquitos which feed and rest inside houses. Use of residual insecticides is advocated only to control malaria outbreaks, and in selected situations. The use of insecticide spraying on a large scale or for long periods is not sustainable because of the high costs, problems with spraying, and mosquito resistance to insecticides.

Spraying in the air with "knock-down" insecticides is useful when prompt action is called for, for example during epidemics and when large populations congregate outdoors at night. The operation is extremely costly and must be carefully timed to coincide with times when mosquitos fly around.

Thus, various options exist for controlling vector mosquitos. These differ in efficacy and input requirements such as finance, technical expertise, manpower and community involvement. When appropriately used, each method can make a valuable contribution to the control of malaria. With a better understanding of how the mosquito breeds and lives, it will be possible to target control efforts even more successfully against this Public Enemy No. 1 in many countries. ■

Dr Awash Teklehaimanot and ***Dr Pushpa R. J. Herath*** are Scientists with the Malaria Control Unit, WHO, 1211 Geneva 27, Switzerland.

IDEAS FOR ACTION

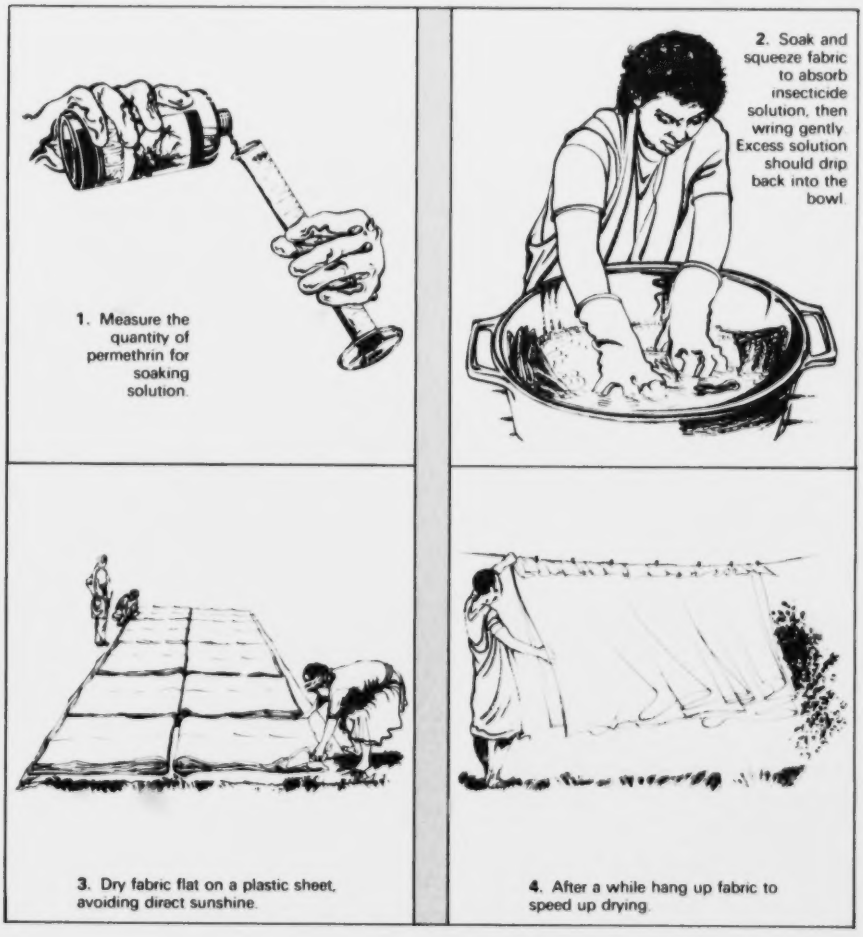
Bednets against malaria

One of the best ways of preventing malaria is to avoid coming in contact with mosquitos. Many people use bednets (mosquito nets) to protect themselves against insect bites. When properly used, they also help to protect against malaria. Always tuck the lower edge of the bednet under the bedding in order to be sure to keep the mosquitos out; they are after your blood!

The nets can be easily used by anyone, and are not very expensive. They can be made by hand or machine in a variety of mesh sizes, textures, weights and colours. Those sold in shops are usually made of a fine mesh of cotton or synthetic fibres such as nylon or polyester. There are many different sizes, shapes and methods of hanging them.

Impregnating the net with an insecticide makes it even more effective, and this is proving to be an important way of controlling the spread of malaria. By killing mosquitos that come in contact with the net, the insecticide reduces the risk of being bitten. Even when the net is not in use it kills mosquitos that touch it. Only insecticides containing pyrethroids should be used.

Here are some of the advantages of using impregnated bednets:
— they are easy to use;
— they reduce the exposure of children to insect-borne diseases;
— other pests besides mosquitos are also killed, such as cockroaches, fleas, lice, biting flies, ants, houseflies, mites and bedbugs;
— they allow one to sleep in relative comfort;
— they provide privacy.



1. Measure the quantity of permethrin for soaking solution.

2. Soak and squeeze fabric to absorb insecticide solution, then wring gently. Excess solution should drip back into the bowl.

3. Dry fabric flat on a plastic sheet, avoiding direct sunshine.

4. After a while hang up fabric to speed up drying.

A mosquito coil

A plant against mosquitos!

The pyrethrum plant (*Chrysanthemum cinerariaefolium*) contains active substances (pyrethrins) which are toxic to insects. The active material can be extracted with a solvent from the dried flowers and stems and is commonly used in household hand sprays. Dried pyrethrum flowers ground to a powder or the extract are used to produce anti-mosquito sticks and coils. Due to uncertain supplies, however, as well as the recent introduction of several new and more effective synthetic pyrethroids, the use of pyrethrum has recently declined.

The use of bednets can be promoted through community action.
- Bought in large numbers they are much cheaper than bought singly.
- Impregnation with insecticide can be done at home, or jointly by all the villagers with the assistance of health personnel.
- Bednets can also be manufactured locally.

Contact your nearest malaria control programme for further information.

Bednets that kill mosquitos

Anyone can learn to impregnate a bednet. The most difficult part is preparing the insecticide solution. Once the solution has been prepared in the correct strength and the correct amount, the impregnation of the net is simple. The illustrations show how bednets can be impregnated.

Bednets can also be sewn at home. That is much cheaper than buying them ready-made. Why not start a family or community project?

Illustrations were prepared by the Division of Control of Tropical Diseases, WHO.

Learning about malaria in schools

The life-cycles of the malaria parasite and the mosquito make excellent themes for a natural science course (see pages 16 and 17). They should also form an important part of health education in school and out of school, particularly in areas where malaria is rife. In most countries, educational materials such as films, filmstrips, posters, flannelgraphs and booklets are available. They can help you in preparing interesting learning-teaching sessions. Ask your ministry of education, ministry of health, or the local education or health authorities to help you to obtain such materials.

Malaria personnel or other health workers in your area might be willing to take part in the teaching. For example, they can help to identify mosquito larvae in ponds or irrigation ditches; they can collect larvae and bring them to the classroom for information—or better still, join in an outing with the pupils to search for larvae. They can point out where mosquitos live and breed, and how to distinguish between the mosquitos that transmit malaria and those that do not. They can demonstrate how to take a blood sample and make a slide for microscopic examination, and how to examine the slide under the microscope to find out if it contains malaria parasites.

Here are some suggestions for what could be discussed at different grades in school:

In the first three grades you might deal with the following themes:

1. The word "malaria" and the local name for it.
2. Persons with malaria have muscle pains, chills and fever.
3. Malaria is carried from the sick to the well person by certain kinds of mosquitos.
4. Walls can be sprayed with chemicals to kill anopheles mosquitos. They do not kill all insects.
5. Use of bednets to protect against mosquito bites.
6. Reporting fever cases to the health worker at an early stage, so that malaria can be treated.
7. People should help the government in every way they can to kill anopheles mosquitos and to put an end to malaria.

Drawing by Peter Davies

In grades four, five and six, the suggested learning objectives may be:

1. To learn what happens when you have malaria.
2. To learn what causes malaria (the malaria parasite).
3. To learn how malaria is spread (how the parasite gets in the mosquito and how it is passed on to humans).
4. To learn how malaria may be controlled or wiped out.
5. To learn what families and the community can do to help in controlling malaria.

At secondary level it is possible to go into much more detail both about the life-cycles of the malaria parasite and of the mosquito. Different strategies for the control of disease can be studied, as well as its social and economic effects on the community.

Some other ways to protect yourself against mosquito bites

- *Sleep in rooms whose windows and other openings are properly screened.*
- *Use anti-fly sprays containing pyrethroid insecticides to kill any mosquitos that may have entered the room in spite of screening, or may have got under the bednet.*
- *After sunset, wear sufficient clothing when you are in the open air to protect the body, arms, and legs from mosquito bites (long sleeves and long trousers or skirts).*
- *Apply insect repellent on those parts of the body that are not covered by clothing.*
- *Smouldering mosquito coils which offer protection for up to six to eight hours are popular and inexpensive. They are most effective indoors and in the evenings.*

Mosquito nets come in different sizes and shapes. Here is one specially made for babies.

Teaching methods will be chosen by the teacher, and the students should be actively involved. The health educator can help the teacher to select suitable activities and teaching materials. The children can help to clean up the school and surroundings to remove mosquito breeding places. Community leaders, health workers, teachers and pupils could together monitor the school and surroundings to find possible mosquito breeding places and eliminate them.

In one country a study made among teachers and students found that the questions most frequently asked about malaria were:

a. Do we have malaria here?
b. What causes malaria?
c. How can you tell if a person has malaria?
d. How do you cure malaria?
e. What do I do if I have malaria?
f. Do all mosquitos carry the disease?
g. Where do mosquitos live?
h. How do you kill mosquitos?
i. Do mosquitos carry other diseases?
j. Do other countries have malaria?

The teachers' role in the early detection of malaria

In areas with malaria, teachers can play an important role by detecting cases of fever among pupils and referring them to the health worker, who can then take the necessary action. Teachers can also monitor how often students are absent and for how long, and inform the health centre when children are absent more frequently or for longer periods than usual.

Malaria can only be controlled if everyone participates in the fight. Why not contact the staff in your nearest health centre or hospital to discuss what you can do together to teach schoolchildren about malaria and become partners in controlling the disease? ■

Travellers, beware!

by Penelope Phillips-Howard

Whether they are on business, on holiday or visiting relatives, international travellers are at risk of catching malaria when they visit an endemic area. Other groups, such as itinerant workers and refugees who come from non-malarious areas and who are compelled to move to a place where the disease is common, are also greatly at risk, requiring close attention from the host governments or agencies.

Every year non-malarious countries of Europe, North America, the Far East and many other countries in the southern hemisphere report cases of "imported" malaria in travellers who have returned from malarious areas. The number of cases of imported malaria reported to WHO has doubled over the past decade, largely as a result of mass tourism to tropical locations. At present, some 10 000 cases are reported in Europe and over 1000 in North America every year.

Not all travellers visiting malarious countries are automatically at risk of contracting malaria; for example, travellers visiting major cities in South-East Asia such as Bangkok or Singapore will generally not be exposed to malaria transmission.

The highest risk of contracting the most dangerous species of malaria, *Plasmodium falciparum*, occurs in travellers visiting malarious areas in Africa, south of the Sahara. As many as one in every hundred visitors to countries of West Africa, such as Nigeria and Ghana, become infected and have symptoms of the disease on return to their home country.

The activities and behaviour of individuals influence their risk of becoming infected, which depends on their

Tourists need to be aware that danger may lurk even in a tropical paradise.

Golden Rules for Travellers

If you intend to travel to areas where there may be a risk of malaria:

1. **Contact your physician or an institution which can be trusted to give competent advice, e.g., a vaccination centre. Request advice on whether there is any malaria risk where you are going; if there is, ask which antimalarial drug to take for prevention, how to take it, and what side-effects it may have.**
2. **Take the drug in the exact dosage prescribed and continue for four weeks after leaving the malarious area.**
3. **In malarious areas, take sensible precautions. Sleep in screened rooms or under bednets, preferably impregnated with insecticide; from dusk to dawn wear clothes that cover arms and legs; cover unprotected skin with an insect repellent.**
4. **Be aware of the symptoms of malaria infection. If you have an unexplained fever, headache, muscular aching, vomiting or diarrhoea on returning from a malarious area, seek medical advice at once and tell the physician where you have been. Malaria can manifest itself up to a year after departure from a malarious area, even if antimalarial drugs have been used.**
5. **Remember that malaria can rapidly become severe and may cause death less that 48 hours after the first symptoms have appeared.**
6. **For pregnant women, small children, and persons with chronic liver, kidney or heart disorders, it should be considered whether the journey is really necessary; consult a physician.**

different degrees of exposure to mosquito bites and their varying abilities to seek and use methods of prevention. Malaria occurs much more frequently in migrant populations who travel to their former homeland to visit family and friends than in other travellers going on business or vacation. This is because they often do not receive information about the risk of malaria and they stay in areas where malaria transmission may be higher than in business or tourist locations.

Misunderstandings about what causes malaria and how it can be prevented are common among travellers; in one survey of European travellers, only 30% knew that malaria was transmitted by mosquitos biting between dusk and dawn. Some participants who were questioned even thought that malaria was transmitted from drinking contaminated water! The presence of parasite resistance to antimalarial drugs also plays a major role in the risk of malaria disease and death. Travellers may not be aware that their antimalarial drugs taken for preventive purposes are not one hundred percent effective and may therefore fail to seek medical help if malaria symptoms develop. If deaths from malaria are to be prevented, physicians must understand how important it is to start treatment with *effective* antimalarial drugs very early in the course of disease in order to prevent the development of life-threatening complications.

A number of "golden rules" are recommended by WHO and national authorities regarding malaria prevention (see box on page 24). Both travellers and their physicians should be aware that visits to malarious countries may result in infection which, if not properly recognized, can result in disease and death. A tragic example of what can happen occurred recently when a married couple returned to Europe from Uganda. When the flight arrived, the wife was immediately admitted to hospital with *P. falciparum* malaria. The husband also felt unwell but returned to their home. One week later, the wife was discharged from hospital only to find her husband dead at home; he too had contracted malaria but was unable to seek medical help.

All cases of febrile disease in persons who have recently visited malarious areas should be examined by microscopy of the blood for the presence of malaria parasites. If a first examination is negative, it should be repeated several times.

Certain population groups are strongly advised not to visit a malarious country unless they really have to; they include young children, pregnant women, the elderly, and people with chronic diseases such as liver, kidney and heart disorders.

Planning to go abroad?

Drawing by Peter Davies

Whether crossing continents or just the nearest border, international travel can be a great way to broaden your horizons. It can also introduce you to some rather nasty local microbes, like all those viruses, bacteria, protozoa, and other exotic bugs that love to prey on strangers. Masters of disguise, local infectious agents can get you via a sip of water or a bite of salad, a shower, a sting, ice cream, shellfish, or simply the air you breathe.

Every year, the hazards of going abroad make travellers the victims of some very serious diseases. Which is why the World Health Organization issues a book on vaccination requirements and health advice for international travel every year.

Designed to safeguard the health of travellers, the book alerts health authorities to changing immunization requirements and other measures of protection against the hazards of going abroad, including considerable information on the malaria risk. The book will give your doctor or travel agent a good idea of this and other risks that may be waiting in the intended country of travel. And will help them advise what you must do to protect yourself and your health.

Be advised before you go

International travel and health

Vaccination requirements and health advice, situation as on 1 January 1991. 94 pages. Sw.fr. 14.–

Available from WHO, Distribution and Sales, 1211 Geneva 27, Switzerland.

Wherever malaria occurs, travellers should protect themselves against biting mosquitos through the use of bednets, repellants and similar measures.

Antimalarial drugs need to be taken with unfailing regularity. However, travellers should be made aware that no drug gives one hundred per cent protection against infection and that malaria should be suspected if a fever develops, even when drugs have been taken exactly as prescribed. Cutting down on the dosage because of fear of overdose, loss of tablets, mild side-effects such as nausea, or belief that immunity has been achieved, all lead to an increased risk of infection. Continuing medication after returning home is always a problem, since there appears to be no further risk from biting mosquitos. But malaria parasites may still be present in the blood, and medication is important for four weeks after leaving the malarious area.

Unusual outbreaks of malaria may sometimes occur in non-endemic countries. In recent years there have been several instances of malaria transmission around international airports in non-endemic countries. Very rarely, malaria has been transmitted by contaminated needles, e.g., in drug addicts. The risk of getting malaria through blood transfusion is considerably greater (parasites may be present in the blood of apparently healthy donors). In some non-malarious countries, blood donations are therefore not accepted from persons who have visited malarious countries.

Greater awareness of the dangers of malaria for travellers is needed at all levels of the travel market. Tourism organizations, airlines, business consortiums and other such institutions must recognize the hazards associated with international travel and their responsibility to minimize the risk of illness and death from malaria in their clients and personnel. At national and international levels, improvements are required in guidelines to ensure that travellers to malarious countries receive adequate protection against malaria infection, that their symptoms of malarial disease are recognized and diagnosed promptly, and that appropriate medical steps are taken. ■

Dr Penelope Phillips-Howard is a Scientist with the Malaria Control Unit, WHO, 1211 Geneva 27, Switzerland.

Risks during pregnancy

by Bernard J. Brabin

In the early 1970s a Dutch doctor, Francis Kortmann, began to study the problem of malaria in pregnant women at a rural hospital at Muheza in Tanzania. Some years later in a small Dutch library I accidentally came across his thesis written on this subject. The clinical, parasitological, obstetric and immunological details he reported in his studies of several hundred women convinced me that, when malaria occurs during pregnancy, it poses a major health problem in tropical countries.

Highly vulnerable

Since that time I have been involved with field research projects in western Kenya and coastal Papua New Guinea which have given priority to investigating why pregnant women are at special risk of getting malaria, the size of the problem, and how it can be prevented. These studies have shown that, in areas where malaria is transmitted year-round, pregnant women have frequent episodes of malaria from early to mid-pregnancy.

In their first and possibly second pregnancy, women are especially vulnerable, because in later pregnancies they build up more resistance to the malaria infection. One of the surprising findings from these studies was that most women did not complain of acute symptoms of malaria such as high fever and shivering episodes. It would appear that, despite these recurrences, the infection generally remains partly controlled by the mother's immune system. As a result the infection may often be clinically unrecognized, and it is only when a blood sample is taken for a malaria smear that it is diagnosed. This is why pregnant women are at particular risk.

Low-grade infection can lead to an increasing degree of anaemia in the mother, which in some cases develops into severe anaemia by the time of delivery. If the mother then loses blood during childbirth, her life is in danger.

Women are more vulnerable to several infections during pregnancy because their immunity is either not yet fully formed or has been altered. Malaria is only one of the factors which increase the risk for ill-health or death in pregnant women, but when associated with anaemia it is probably the most important one, especially if the level of immunity to malaria is low. Anaemia from other causes such as iron deficiency is very common in many tropical areas, further increasing the risk. Often 70% to 80% of pregnant women in malarious regions are anaemic. This situation can be improved by controlling malaria transmission (for instance, by preventing mosquito breeding or using bednets) and by treating the anaemia with iron and folic acid.

In areas where malaria is endemic, pregnant women should be given antimalarial drugs and iron and folic acid supplements at their first antenatal visit whether or not they have symptoms. Ideally this should take place early in pregnancy as this is an important period for fetal growth. If delayed until later in pregnancy, the benefits to the mother and fetus may be limited.

Pregnancy in young girls increases the risk of complications from malaria and anaemia, because their own growth process is not yet completed; this leads to delivery complications and to competition between the girl and the growing fetus for nutritional requirements. In areas with high levels of malaria transmission adolescent girls should be screened for anaemia even if they are not pregnant. Those with anaemia should be treated so as to reduce the risk of starting their first pregnancy in an anaemic state.

Retardation of fetal growth, with resulting low birth weight, mainly affects babies born from first pregnancies. Pre-term delivery may also result from malaria, but this more commonly occurs in women with low immunity to malaria, such as those from non-endemic areas. In some endemic areas, as many as 40% of babies of first pregnancies have low birth weight because their mothers had malaria.

Clearly it is important to protect pregnant women from malaria. The drugs currently recommended for prophylaxis are limited to chloroquine (weekly) and proguanil (daily). Both are considered safe drugs to take during pregnancy. Because the parasite is becoming resistant to chloroquine, other drugs are being sought for use in pregnant women. The best advice for non-immune women would be not to travel to an endemic area if they are pregnant. Women who live in malarious areas should attend an antenatal clinic as early as possible in order to receive the necessary care. In areas where this is not possible, studies have shown that the distribution of antimalarial drugs by village health workers can offer real benefits for mother and child. ■

Dr Bernard J. Brabin is Senior Lecturer in Tropical Paediatrics, Department of Tropical Paediatrics International Child Health, Liverpool School of Tropical Medicine, Pembroke Place, Liverpool L3 5QA, Liverpool, U.K.

Photo WHO/G. Gramiccia

Women in developing countries are often anaemic. If they become pregnant and have malaria, their health is in serious danger.

Photo WHO/TLO

Economic development and malaria

by Bernhard H. Liese

Brazil's gold rush has brought an influx of young men in their twenties and thirties to the Amazon basin. Many of these would-be miners, "garimpeiros", come from the ranks of landless farmers and unskilled rural and urban workers. Most of them leave the "garimpos", the gold mines, little better off than when they arrived. Very few strike it rich. In the garimpos they live in houses without walls, and they pay prices for basic goods which are four times higher than in the nearest town.

They have one more thing in common: most of them suffer from malaria. Coming from the south of Brazil, they have never been exposed to the disease and they get it violently. They take drugs—all kinds of drugs—but only until the symptoms are gone and then they go back to work. They transport malaria with them when they go back to visit relatives or friends, or when they find some time to spend all their savings and then return to the mines to start all over again. This situation is repeated in many frontier areas of the world where uncontrolled gold or gem mining has become a major occupation—and where malaria runs rampant. Sometimes when we talk about malaria, we tend to forget that—besides the mosquito and the parasite—the disease is also intimately linked to human activities and movements and the course of economic development.

Disorderly migration

This inescapable relationship is one of the most important lessons we have learned in malaria control. In Brazil's Amazon basin, for example, we find today a rapid and disorderly migration of farmers, prospectors and entrepreneurs, an increasing vulnerability among native Indians, and an explosive growth of malaria. A combination of environmental, social, economic and even political factors have interacted to produce what has been labelled frontier malaria. It is by no means evenly distributed all over Amazonia, since only 40 out of 450 municipalities account for over 80% of all malaria cases. Indeed, malaria is basically localized in three major environments: the infamous gold mining areas; areas of new agricultural settlement; and the rapidly expanding peripheries of many new small cities.

What happens in new settlement areas, especially among farmer migrants who have had no prior contact with malaria, is dramatically shown by the situation in the Machadinho settlement project in Rondonia, Brazil. In the first year of settlement, 1200 cases of malaria were reported in a total population of 2000 people. The situation deteriorated quickly, to the point where two years later, 24 000 cases of malaria were reported in a population of 13 000 people! As settlements get older and more established and as control measures are gradually introduced, the overall malaria picture begins to improve.

As this example demonstrates, malaria is intimately related to migration of a permanent nature which often occurs when possibilities for economic opportunity and social mobility are perceived in a certain region. Malaria is also a problem in

(Above) Gold-diggers in Brazil may take home with them more than just gold.

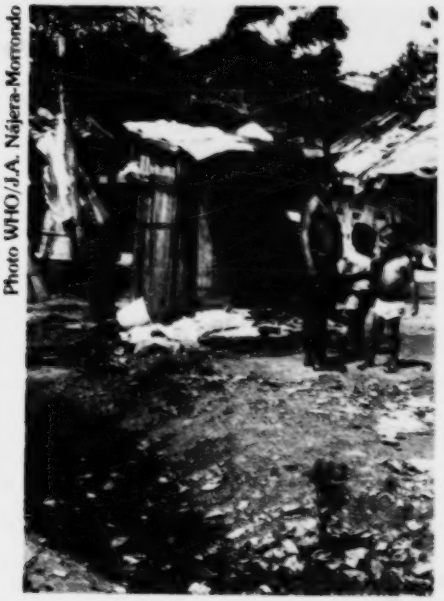


Photo WHO/J.A. Nájera-Morrondo

Suburban slums: an ideal breeding-ground for mosquitos.

areas where seasonal migration is important, for instance, in places where there is demand for temporary labour during the planting and harvesting seasons.

Road construction projects result in pits which fill with water being left alongside the newly constructed road. In Papua New Guinea, when a road was built to link the coastal plains to the highlands, suddenly localized malaria epidemics occurred in previously malaria-free areas. In effect, the mosquito vector had been keeping up with the road construction, moving from pit to pit.

Breeding grounds

The negative health impact of large dam constructions has attracted considerable international attention, although schistosomiasis rather than malaria has been the major health issue. Quite often, in fact, it is not in the reservoir area that malaria is the overriding problem, but rather downstream where water for irrigating agriculture may be left standing for long periods of time. This provides ample breeding grounds for the mosquito.

Where there are irrigation channels for rice and sugar cane, the situation is especially difficult since both of these crops require the heavy use of agricultural pesticides. This use contributes to the development of pesticide resistance among certain disease vectors. So malaria control becomes very difficult.

In the most malarious part of the world, Africa, malaria has been a fact of life for millennia. But economic development has altered the patterns of transmission and in many cases increased the devastating impact of the disease. In many rapidly growing cities of West Africa, for example, what used to be a predominately rural disease has now become an urban problem. Many of the coastal cities, in fact, are less real cities than a collection of many rural villages clustered together around a small urban core, and people move constantly between the outskirts and the countryside.

Sometimes economic development results in a decline in malaria. This has happened in some of the areas of irrigated agriculture in Africa and Asia, where modern methods are used and where fields are meticulously maintained.

Where does this leave us as regards future control efforts? The first lesson is that malaria is not only a devastating disease transmitted by a mosquito but also a social condition closely related to economic development. In the past, malaria control was merely defined in technological terms, and we tended to forget that we must also consider occupational and social conditions and the economic activities that people undertake. If we do take these into account, then we see that there are only a limited number of general scenarios. To quote some of the most important ones: we have frontier malaria in the forests of Amazonia, Thailand, Kampuchea and Ghana. There is highland fringe malaria in Rwanda or Papua New Guinea, where people live in the hills but work their fields in the malaria-infected valleys. We have malaria where there is irrigated agriculture, and urban malaria. And we have malaria in areas of social and political unrest—particularly where refugees have settled and where normal agricultural activities are disrupted.

In summary, malaria is not only a major public health problem but also an important obstacle to development. Its spread is linked to specific development policies and actions such as road building, new agricultural settlement and irrigation projects. And in many areas of the world it is a social condition that is closely associated with the development of rural areas and the movement of underprivileged populations. ■

Dr Bernhard H. Liese is Director, Health Services Department, The World Bank, 1818 H. Street NW, Washington, DC 20433, USA.

The economic impact

The impact of malaria on the economy of the local community or the household can be assessed as *direct costs*—the cost of treatment and control programmes—or as *indirect costs*—the value of income lost through disease and death. Different methods are used to estimate the effects of illness on productivity. For example, days of disability due to malaria range from five to 20 days. The cost of replacement labour to undertake agriculture activities while one family member is ill is another measure, but it is often difficult to estimate.

There are other variables. Families who customarily suffer from malaria tend to replace high-value crops which have to be farmed during the malaria season by low-value crops which can be farmed outside that period. Furthermore, quite often, other family members will increase their own workload in order to make up for one who is ill. So we now believe that the household is a better unit than the individual to measure lost productivity in malaria. One of the most detailed studies ever undertaken shows not only that malaria results in increased work by healthy family members on behalf of ill ones, but also that, despite the help of family members, neighbours, children and sometimes hired workers, the average reduction in the agricultural productivity of a *household* during the period of heavy malaria transmission can be as much as 30%.

Malaria also undermines the effectiveness of investment in education. In highly endemic areas, the learning capacity of an estimated 35% to 60% of schoolchildren may be impaired by malaria.

How much do *governments* spend on malaria control? Many governments allocate considerable funds, including scarce "foreign exchange" (hard currencies) to buy pesticides or imported equipment, since it is essential to maintain a productive agricultural sector. In the absence of sufficient data, it is difficult to draw up a realistic balance sheet between the cost of malaria's impact on the economy and the cost of controlling the disease.

Estimates of direct costs due to malaria will include the cost borne by patients seeking care. In Thailand, for example, this amounted to US$ 20 per positive case or nine times the average daily wage of the patients. Again, the cost of malaria control per case prevented may range from $2.10 to $260 because of differences in the ecological, epidemiological or social characteristics of areas and in the severity of the disease. Even the lowest figures would make malaria control a priority for the allocation of the government resources. There is not the slightest doubt that malaria has a very serious impact on the economy.

A game of chess

by Michel Lebras

At a time when the malaria parasite's resistance to chloroquine is spreading throughout Africa, all the way from the southern Sahara to South Africa, while resistance to quinine and many other drugs—whether taken singly or together—is advancing in certain parts of Asia, tropical America and East Africa, pharmacological research has put at our disposal new therapeutical weapons. These are mefloquine, halofantrine, and the derivatives of a Chinese plant called qinghaosu—artesunate and artemether.

Operational research is meanwhile helping us to plan the strategies for using these drugs. Studies are being made of their efficacy based on an evaluation of the rates of cures achieved, of their harmlessness (by measuring the degree of tolerance in patients), of their cost (taking into account not only the price of the drug but also the cost of not treating malaria victims), and finally of their accessibility and the degree to which patients observe the prescribed regimens.

"Does the large-scale use of the drugs have any overall impact on the malaria situation?" is another important question. In fact, field trials have already shown that the correct use of these drugs has cut down mortality and considerably reduced morbidity from malaria.

A thinking parasite?

The malaria parasites are haematozoa—that is, they live in human blood—and it is the small anopheles mosquito which transmits the parasites by biting, at random, first a malaria patient then a healthy person. These parasites—and this is more true for *Plasmodium falciparum* than for any other—have a remarkable capacity for adapting themselves to drugs and thus escaping their effect. For instance, in certain foci in South-East Asia, over 50% of the falciparum malaria found are already resistant to mefloquine even though this drug has only been in use since 1984.

So it is vital to discover new medicaments. Research workers, exploring various avenues, are thinking up new ways to attack the haematozoa; their affinity for certain lipids (fats), for example, seems to offer a potential strategy for creating new drugs.

The most serious forms of malaria could be controlled by using drugs which would prevent the infected red blood cells from adhering to the wall of the deep capillary vessels, the formation of clusters of red cells in the form of "rosettes", and the release of toxic substances, all of which result in such complications as bleeding and the formation of blood clots in the smallest blood vessels. Promising tests have been made with the antibodies of immunized people, and with chloroquine, which could play a role in inhibiting the harmful effects of toxic substances.

A great number of molecular substances are at present being experimented with, either in the laboratory on cell cultures, in animals or in man. Natural substances extracted from the traditional pharmacopoeia, such as the qinghaosu mentioned above, are not being overlooked in these tests.

But at present a most promising approach is one which would enable us to overcome resistance to chloroquine by keeping the drug in contact with the parasite. Certain substances used in the treatment of cardiovascular diseases, such as antagonists of

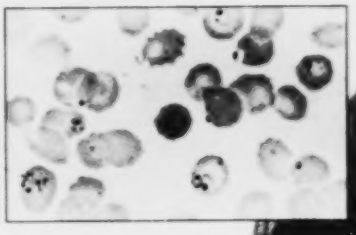


Photo WHO

Photo WHO/Zafar

The parasite has a remarkable capacity to develop resistance to drugs. Scientists are working hard to find new ones. The microscope slide shows the* Plasmodium falciparum *inside a red blood cell.

Photo WHO/S. Lindsay

Catching mosquitos to enable research workers to learn more about the enemy.

calcium or certain antidepressants and antihistamines, seem to be capable of playing this role when they are administered with chloroquine.

Recognizing the parasite

Diagnosing malaria at present depends on detecting the haematozoa in the blood by use of the microscope. But this technique, in use for more than a century, is of limited value when there are only a few parasites in the blood. In fact, microscopy does not enable us to distinguish between human carriers of the disease who show no symptoms and active malaria, which calls for treatment.

New tests are at present under development. Thanks to the use of molecular probes we can detect different fragments of the parasite in the blood.

One particularly promising technique, already being applied in the field, calls for the blood sample to be separated by centrifuge in capillary tubes and then coloured with acridine orange. This makes it possible to detect the parasites, even when they are few and far between. Today this method is the most sensitive and the quickest. However, its main drawback is the lack of specificity, since it may sometimes give a positive result even when there is no malaria. Also, special microscopes are needed. All the same, molecular biology is undoubtedly making giant strides and gives us plenty of grounds for optimism.

And a vaccine?

All research aimed at controlling malaria comes up against the complex nature of the parasite. It is possible to interrupt the development of the parasite at several points. The identification and choice of antigens which could form the basis for design of "candidate vaccines" can be narrowed down by analysing the natural history of malarial immunity. Long-term research carried out in the little village of Dielmo in Senegal has given us a better understanding of how the mediators of immunity operate. In an area where the transmission of malaria still continues, some children have several attacks of fever each month, while others never have them. The research workers are trying to find out why. A new technique now being developed should make it possible to multiply some of the fragments of the parasite which stimulate immunity. These might be used to prepare an effective vaccine.

No contact with mosquitos, no malaria

If we could prevent all contact between man and the anopheles mosquito which transmits malaria, this disease would not exist. The advent of synthetic pyrethroids which are capable of repelling the mosquitos, such as permethrin and deltamethrin, has given us high hopes of considerably reducing this insect-and-man contact. Deltamethrin in particular is desirable for its efficacy, its long-lasting action (as long as six months) and its harmlessness for man and the environment.

The optimal ways of using these substances depend on the biology of the mosquitos, and this ought, therefore, to form part of initial entomological studies. Bednets, especially when they are impregnated with deltamethrin, have proved to be effective in many evaluation studies. However, a good deal of research still needs to be done before we can say exactly what is the role of impregnated bednets under various epidemiological conditions.

There must be no letting up of research. We have to find other weak points in the haematozoa. We need to know more about how to use antimalarial drugs more effectively, to find better diagnostic techniques for the different forms of malaria, and to improve the planning, programming, management and evaluation of control measures.

The haematozoa is ingenious, dauntless and apparently gifted with eternal life. We are playing a game of chess with it. At stake are the lives of the 2000 children who succumb to malaria every day in the world. ■

Professor Michel Lebras is Director of the René Labusquière Institute at the University of Bordeaux II, 146 rue Léo-Saignat, 33076 Bordeaux Cedex, France.

NEWS PAGE

Editor: Philippe Stroot

Ministerial Conference on Malaria

The World Health Assembly, which meets every year in Geneva, passed a resolution in 1989 stating that malaria control must be a global priority, essential for the achievement of health for all, and emphasizing the crucial role of WHO.

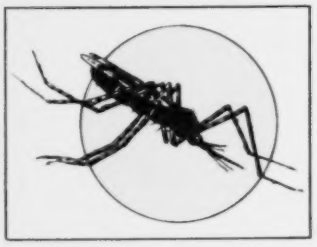
Since there appeared to be little recognition of the worldwide malaria problem, the WHO Executive Board the following year recommended that a global malaria conference at ministerial level should be organized to focus on the worsening situation, to adopt strategies of malaria control, and to strengthen commitment to these strategies by political and health leaders and among donor agencies.

WHO/P. Almasy

Case-finding in Mexico

The Ministerial Conference on Malaria has been scheduled for 26–27 October, 1992, in Amsterdam, Netherlands. The Minister of Health and one technical representative from each of the 95 countries where malaria remains a problem will attend.

Prior to the Conference, technical representatives of Member States will be invited to a series of interregional meetings which will each analyse the regional malaria situations, develop appropriate control strategies and discuss particular issues of regional interest. The first of these meetings will be held in Brazzaville (21–25 October 1991) and will specifically discuss savanna, urban, desert fringe and highland fringe malaria. A meeting in New Delhi (3–7 February 1992) will concentrate on the problems of drug resistance and the impact of current epidemiological knowledge on malaria control. A meeting in Belem, Brazil (21–25 April 1992) will analyse malaria in terms of social and economic development and discuss intersectoral collaboration.



Not only countries with endemic malaria but all interested countries and parties are being involved in this initiative to control malaria. WHO is fully committed to making it a success. The time to prevent death and to diminish physical, economic and social suffering from the scourge of malaria is long overdue. ■

Newsbriefs

• **Doctors against nuclear war.** *WHO's Director-General, Dr Hiroshi Nakajima, participated in the 10th World Congress of International Physicians for the Prevention of Nuclear War (IPPNW), held in Stockholm from 27 to 30 June 1991. In an address to 1400 physicians from 78 countries, he recognized the complementarity of the work of WHO and IPPNW in aiming to achieve the highest attainable standard of health for all citizens of the globe.*

• **The first World Diabetes Day** *was celebrated on 27 June 1991, to coincide with the 14th Congress of the International Diabetes Federation. WHO co-sponsored the Day, in the hope that this action will serve to draw further attention to the needs of people with diabetes. At least 60 million people in the world suffer from this disease. While its prevalence in most western communities is estimated at 2–5%, it is now known that in some developing populations it can reach 10% or even 20%. The frequency of diabetes rises with age. In the worst-affected communities, more than half the population will develop the disease if they live to old age. WHO has prepared guidelines to assist Member States to develop national programmes for diabetes. They are available, on request, from the Diabetes and Other Noncommunicable Diseases Unit, WHO, 1211 Geneva 27, Switzerland.* ■

In the next issue

The November–December 1991 issue of *World Health* will describe the special health concerns of the European Region of WHO and the innovative approaches used to improve the health of the people.

If you would like to obtain the catalogue of WHO publications, or receive sample copies of other WHO periodicals which you want to evaluate before placing a subscription, please contact: World Health Organization, Distribution and Sales, 1211 Geneva 27, Switzerland

Did you enjoy this issue?

Why not take out a subscription to *World Health* and enjoy reading about the world's major health issues six times a year. 1992 subscription rates are listed below.

WHO also offers its popular "Health Horizons" subscription, a combined subscription (at a reduced rate) to *World Health* and the quarterly *World Health Forum*.

Order form

☐ World Health (1992 subscription) at Sw.fr. 28.–/US $22.00

☐ Health Horizons (1992 subscription) at Sw.fr. 80.–/US $64.00

☐ Payment enclosed

☐ Please charge to my credit card

☐ Visa ☐ American Express

☐ Eurocard/Mastercard/Access

Card no. .....

Expiry date ..... Date of order .....

Signature .....

Name .....

Address .....

.....

.....

WHO · DSA · 1211 Geneva 27 · Switzerland

Photo WHO/Institut Pasteur

A public enemy